REGIONAL SCALE NODES OPERATIONS AND MAINTENANCE BASIS OF ESTIMATES

Version 1-00
2011-05-10

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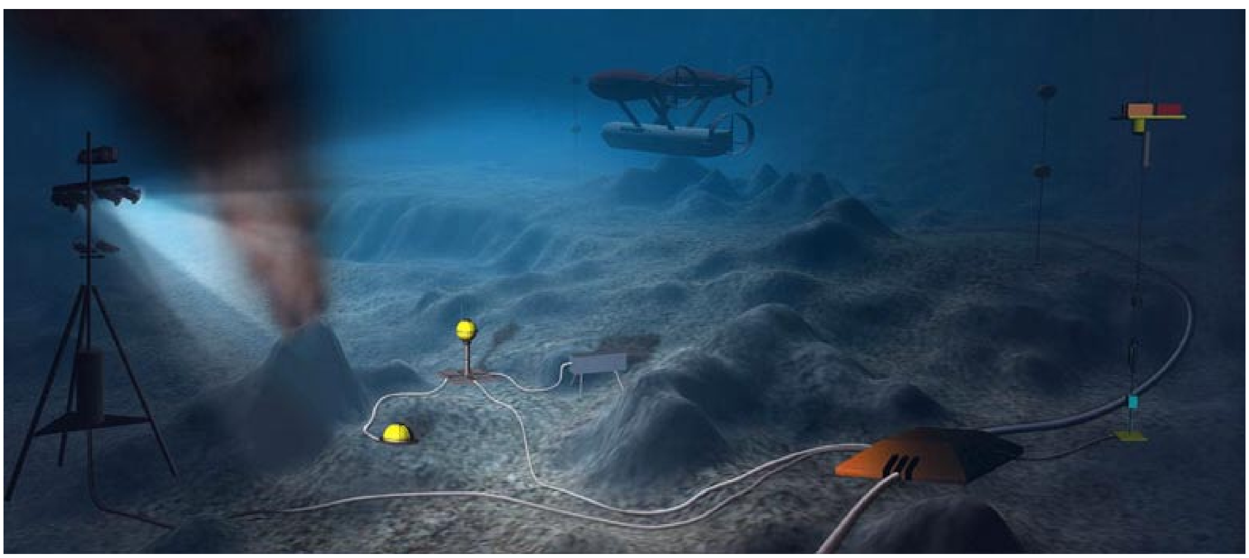
Regional Scale Nodes Operations and Maintenance Operations Basis of Estimate

Version 1-02



Prepared by
University of Washington for the
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Document Control Sheet

Version	Release Date	Description	By
1-00	05052011	Initial Version	Bryan, Barletto
1-01	05062011	Update & minor corrections (1.3)	Bryan, Barletto
1-02	05092011	Corrections & clarifications	Bryan, Barletto

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1. Operations

OOI O&M Operations involves the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental Health and Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life cycle for O&M.

1.1. WBS Table

Applicable WBS Numbers supported by this BOE:

Description	WBS# CY2 - 2011	WBS# CY3 - 2012	WBS# CY4 - 2013	WBS# CY5 - 2014	WBS# CY6 - 2015	WBS# CY7 - 2016	WBS# CY8 - 2017
Project Controls Finance	2.4.1.2.1.24	2.4.1.3.1.24	2.4.1.4.1.24	2.4.1.5.1.24	2.4.1.6.1.24	2.4.1.7.1.24	2.4.1.8.1.24
EH&S	2.4.1.2.1.26	2.4.1.3.1.26	2.4.1.4.1.26	2.4.1.5.1.26	2.4.1.6.1.26	2.4.1.7.1.26	2.4.1.8.1.26
QA/QC Audits	2.4.1.2.1.27	2.4.1.3.1.27	2.4.1.4.1.27	2.4.1.5.1.27	2.4.1.6.1.27	2.4.1.7.1.27	2.4.1.8.1.27
Monitoring & Surveillance	2.4.1.2.1.28	2.4.1.3.1.28	2.4.1.4.1.28	2.4.1.5.1.28	2.4.1.6.1.28	2.4.1.7.1.28	2.4.1.8.1.28
Network Planning & Maintenance	2.4.1.2.1.29	2.4.1.3.1.29	2.4.1.4.1.29	2.4.1.5.1.29	2.4.1.6.1.29	2.4.1.7.1.29	2.4.1.8.1.29
Maintenance Cruise Planning	2.4.1.2.1.31	2.4.1.3.1.31	2.4.1.4.1. 31	2.4.1.5.1. 31	2.4.1.6.1. 31	2.4.1.7.1. 31	2.4.1.8.1.31

1.2. Task Description

2011 - Tasking for CY2 for Operations continues the O&M ramp-up by refining the necessary processes and procedures to affect Project Management and Controls, management and oversight of the RSN Environmental Health & Safety (EH&S) programs, management of the QA/QC program, and operation of the network in accordance with the O&M plan.

Primary cabling will be installed by end of summer in CY2 and O&M activities will then include monitoring of the submarine cable equipment. Coordination of personnel training and development and interaction with the contractor is estimated to increase labor by two hours per week.

2012 - Tasking for CY3 for Operations continues the O&M ramp-up by further refining the necessary processes and procedures to affect Project Management and Controls, management and oversight of the RSN Environmental Health & Safety (EH&S) programs, management of the QA/QC program, and operation of the network in accordance with the O&M plan. RSN EH&S will be handled by the Marine Operations Manager and the Scheduler.

In addition, CY3 begins hand off of RSN sub-systems from construction to operations. The Primary Infrastructure acceptance is planned during CY3. Documentation management and visualization is a key activity as these sub-systems handoffs occur.

Maintenance and Repair plans and cruise planning is initiated. Associate Director for Science, Junior Project Scientist and Senior Ocean Engineering will be primarily responsible for these activities. They will be assisted by Data Systems Architect and Science Technician.

2013 - Tasking for CY4 for Operations continues the handoff from construction. Efforts are to begin improving the processes and procedures for Operations & Maintenance of the Primary Infrastructure and to begin managing the accepted secondary infrastructure elements. Active surveillance, management and reporting on the RSN infrastructure performance and quality become a daily routine task. Secondary Infrastructure completes in summer 2013 and surveillance management reporting to begin 4^{th} quarter 2013. These additional activities are expected to add 15% to the workload.

Secondary infrastructure maintenance cruise planning is intensified for two twenty-day cruises planned for CY5, 2014. Requirements are based on current experience gained from one survey cruise per year for the past three years.

Driving activities during the year include test and acceptance of the secondary infrastructure and core instrumentation in seafloor sites at both Hydrate and Axial. O&M activities intensify with the operations center, operations planning of calibration and refurbishment needs, preparation for the refurbishment cycles of the infrastructure, and logistics facility management. This task is the management, tracking and assurance that refurbishment and certifications are documented.

2014 - Tasking for CY5 for Operations continues the handoff from construction. Efforts are to begin implementing the processes and procedures and activate the Science Quality Assurance and Control activities. Based on growing experience, continued re-evaluation of long-term needs in both personnel and materials.

Driving activities during the year include test and acceptance of the hybrid moorings at Hydrate, Axial and the Coastal 600m site on Endurance. O&M activities at the operations center, tracking of calibration and refurbishment activities and vendor management begin the refurbishment cycles for the infrastructure. Logistic tracking of all infrastructure materials and core instruments both on shore and in the water is in full force.

Performance and Quality Management of Data Products and fault repair and resolution expands with added secondary infrastructure and community utilization.

It is estimated that community workshops will begin that will require attendance of operations personnel to describe processes and assistance available to put new instrumentation onto the system.

2015 - Tasking for CY6 for Operations completes the handoff from construction. Efforts are to fully implement the processes and procedures developed in the preceding years and activate the Performance and Quality Management activities and plan for long-term personnel, tools and material needs.

Driving activities during the year include the intensive planning for maintenance cruises (2, 20-day cruises). O&M activities continue within the operations center. Logistics continues the "steady state" tracking and management of all infrastructure materials and core instruments both on shore and in the water.

Management of all maintenance contracts, lease agreements, and vendor warranties continues in full force. Contract and interface agreement reviews become a routine part of the steady state activities and quality improvement process.

It is estimated that community workshops will begin that will require attendance of operations personnel to describe processes and provide assistance for the planning of system growth.

2016 - Tasking for CY6 for Operations continues the steady state O&M activities. Efforts are to improve and implement the processes and procedures developed in the preceding years and the Performance and Quality Management activities and plan for long-term personnel, tools and material needs.

Driving activities during the year include the intensive planning for maintenance cruises (2, 20-day cruises). O&M activities continue within the operations center. Logistics continues the "steady state" tracking and management of all infrastructure materials and core instruments both on shore and in the water.

Management of all maintenance contracts, lease agreements, and vendor warranties continues in full force. Contract and interface agreement reviews become a routine part of the steady state activities and quality improvement process.

2017 - Tasking for CY6 for Operations continues the steady state O&M activities. Efforts are to continue to improve the processes and procedures developed in the preceding years and the Performance and Quality Management activities and plan for long-term personnel, tools and material needs.

Driving activities during the year include the intensive planning for maintenance cruises (2, 20-day cruises). O&M activities continue within the operations center. Logistics continues the "steady state" tracking and management of all infrastructure materials and core instruments both on shore and in the water.

Management of all maintenance contracts, lease agreements, and vendor warranties continues in full force. Contract and interface agreement reviews become a routine part of the steady state activities and quality improvement process.

1.3. Basis of Estimate

Personnel estimates are based on experience of estimators with over 50 years of experience in performing similar activities on submarine cable networks, including the planning, project management, operations and customer service of numerous networks, the last of which connected 12 countries on three continents, terminated in 40 locations and employed 150 employees. In addition the estimates are also based on the experience of our Principal Investigator and Associate Director of Science that have served as Chief Scientist on over 75 research cruises and are experienced with the use of numerous Remotely Operated Vehicles, and a variety of instruments and sensors during complex field programs. Finally these estimates have and will benefit from the experience gained during the construction period. It is expected that the estimates provided here will be updated on a routine basis but represent our best conservative view and are less half of what would be expected for a two submarine cable telecom network.

Confidence is very high in the estimates for the first two to three years but two factors will potentially modulate the later years. First, experience gained as the project transitions more and more from construction to operations (which begins in 2011, increases in 2012, but does not include secondary infrastructure until 2013 and 2014, with 2015 the first year of steady state). This gradual transition provides a significant benefit in the learning curve and skills growth but also provides an opportunity for the second factor.

Process improvement or re-engineering will provide the second opportunity for labor resource modulation as the experience gained is applied to improved processes and tools and an increased knowledge of Customer needs.

Position descriptions can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Equipment estimates are based on actual vendor quotes as provided under the relevant Document Numbers listed in the table below.

1.4. Resource Estimates

Personnel Resources (FTE)	2011	2012	2013	2014	2015	2016	2017
Total: (Operations)	**2.60**	**6.44**	**7.20**	**8.94**	**12.17**	**12.17**	**3.79**
Administrative Assistant	0.20	0.25	0.33	0.50	1.00	1.00	0.33
Assistant Director	0.28	0.50	0.50	0.50	1.00	1.00	0.33
Data Systems Architect	0.20	0.50	0.50	0.58	0.83	0.83	0.17
Director	0.28	0.56	0.56	0.56	1.00	1.00	0.33
Finance & Compliance Director	0.20	0.50	0.50	0.50	1.00	1.00	0.33
Junior Project Scientist	0.39	1.11	1.11	1.32	1.67	1.67	0.50
Marine Operations – Maintenance Manager	0.33	0.94	1.17	1.17	1.78	1.78	0.56
Scheduler	0.20	0.50	0.50	0.50	0.50	0.50	0.17
Quality Assurance Engineer	0.20	0.25	0.50	1.00	1.00	1.00	0.33
Senior Ocean Engineer	0.12	0.06	0.11	0.24	0.33	0.33	0.06
Associate Director for Science	0.19	0.17	0.33	0.54	0.33	0.33	0.11
Science Technician		0.56	0.56	0.56	0.56	0.56	0.17
Undergraduate Students		0.25	0.25	0.50	0.50	0.50	0.17
Mechanical Engineer 4		0.06	0.11	0.19	0.17	0.17	0.06
Principal Investigator		0.28	0.11	0.28	0.50	0.50	0.17
SR. Scientist Sub Contract				$45,000	$88,000	$88,000	$30,000
Programmatic Meetings - Host expenses	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$2000
Computer Hardware, Software	$10,000	$10,000	$10,000	$20,000	$20,000	$20,000	$5,000
Calibration Correction Cards		$4,000	$4,000				
TRAVEL							
O&M Meetings							
O&M Quarterly Mtgs - WG co-lead trips (person trips)	32	32	34	36	36	36	12
Annual Reviews/Prep - Lead, +1	4	4	4	4	4	4	1

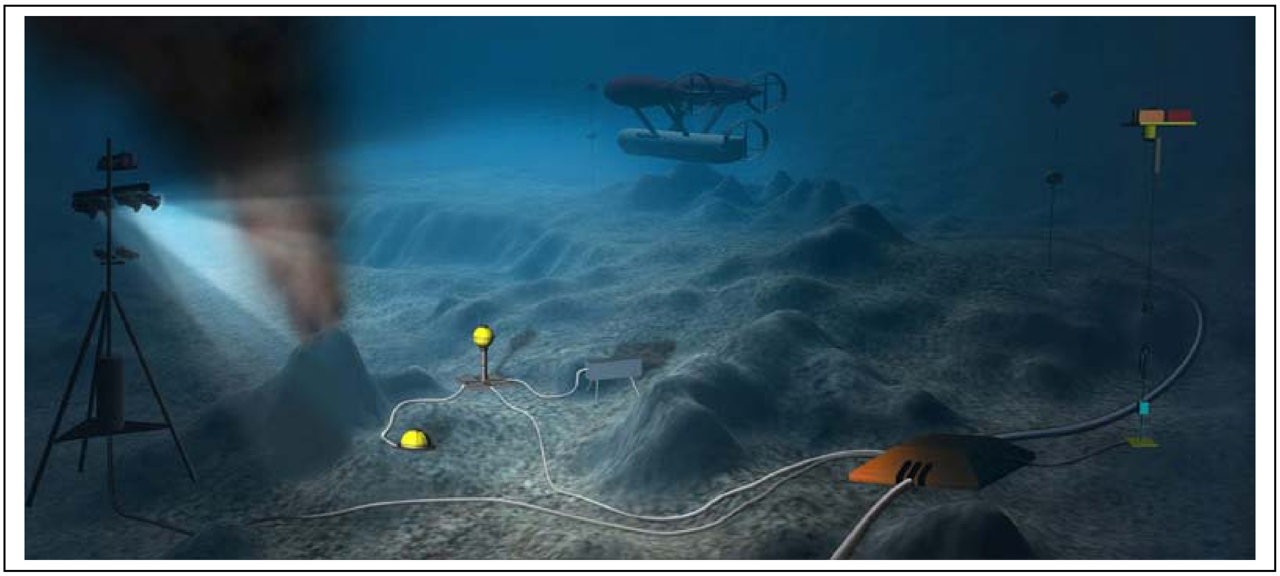
Personnel Resources (FTE)	2011	2012	2013	2014	2015	2016	2017
EH&S & Quality Audits of RSN Facilities		4	6	8	8	8	2
Total Person Trips	36	40	44	48	48	48	15

2012 Equipment Purchases	Estimated Cost	Document Number
Winch	$400,000	4120-66397
Metrohm O2 Titrator	$25,000	4120-66390
Alkalinity Dosimat Titrator	$25,000	4120-66390
Ph Spectrometer	$25,000	4120-66393
Mobile Pressure Recorder	$30,000	4120-66403
Shipping Container	$3,000	Engineering Estimate

2013 Equipment Purchases	Estimated Cost	Document Number
High Temperature Hydrothermal Vent Fluid & Gas Sampler	$112,000	4120-66398
Shipping Container	$3,000	Engineering Estimate

Regional Scale Nodes Operations and Maintenance Data Management Basis of Estimate

Version 1-00



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Document Control Sheet

Version	Release Date	Description	By
0-01	2011-5-04	Initial Version: Started with document *Basis of Estimates for Data QA/QC Resources in RSN component of* OOI (RSN_BOE_Data_QAQC_Resources_2011-04-29_ver_2-00)	O. E. Kawka
1-00	2011-5-05	Expanded Scope of Document to include RSN Metadata Management and O&M Data Product Management Subgroup activities. Added Summary Table by O&M Calendar Year.	O. E. Kawka

DOCUMENT SCOPE

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). This document summarizes the estimates of the resources, as well as the basis of those estimates, required for Data Management during the transition to and operational (steady-state) stages of the Regional Scale Nodes (RSN) Program.

SUMMARY INFORMATION

WBS Table

The applicable WBS Numbers supported by this BOE are presented in the table below:

WBS #	Element Type	Name
2.4.1.2.1.30	WP	Data Management - 2011
2.4.1.3.1.30	WP	Data Management - 2012
2.4.1.4.1.30	WP	Data Management - 2013
2.4.1.5.1.30	WP	Data Management - 2014
2.4.1.6.1.30	WP	Data Management - 2015
2.4.1.7.1.30	WP	Data Management - 2016
2.4.1.8.1.30	WP	Data Management - 2017

Task Description

The tasks associated with the RSN Data Management Work Package during O&M Calendar Years (CYs) 2011 through 2017 include:

1) RSN Data QA/QC

2) RSN Metadata Management

3) O&M Data Product Management Subgroup

These tasks require both shore-based and shipboard resources and activities. Detailed descriptions not included here are provided in other documentation associated with Field Operations and Field Verification. The required resource estimates are based on current programmatic activities by RSN Science and Engineering Staff extrapolated into the future as well as past shipboard and data management experiences by both RSN and external experts in the oceanographic community.

Resource Table

The following table summarizes, by O&M Calendar Year, the resources required for RSN Data Management during the transition to and steady-state operations. The ramp-up to steady-state level of resources for O&M reflects development of operational policies and procedures, collection and archiving of shipboard data and metadata during deployment and maintenance, and the deployment schedule for instrument classes on RSN.

RESOURCE	CY2011 Hours	CY2012 Hours	CY2013 Hours	CY2014+ Hours
UW Associate Director for Science	0	200	300	300
UW APL Senior Ocean Engineer	0	300	300	300
UW Data Manager/Architect	200	300	300	300
UW Junior Project Scientist	450	600	600	600
UW QC Analyst/Scientist	0	900	6300	12600
UW Science Technician	450	800	800	800
UW Undergraduate Students	0	450	450	900

1) BASIS OF ESTIMATE FOR RSN DATA QA/QC

INTRODUCTION

This section of the document summarizes the estimates of the resources, as well as the basis of those estimates, required to assure data quality from the Regional Scale Nodes (RSN) component of the Ocean Observatories Initiative (OOI). This summary includes the assumptions utilized for those estimates; anticipated roles and responsibilities of the RSN Data QA/QC team; brief descriptions of the instruments, deployment thereof, and anticipated data products; frameworks for the QC work activity; and estimates of the resources required.

This document is not derived from nor is it dependent upon either the RSN Quality Assurance and Quality Control (QA/QC) Plan or the overarching OOI QA/QC Plan. ***The QA/QC referred to herein addresses specifically QA/QC processes associated with RSN data streams.*** *This does not preclude eventual inclusion of Data QA/QC in the above documentation. Furthermore, the descriptions of the Data QA/QC processes here are used only to provide a framework for estimation of resources needed and not meant to either detail or summarize all of the policies and procedures of RSN Data QA/QC. Such specific information will be detailed in future documents.*

DATA QA/QC SUMMARY INFORMATION

The following table summarizes, by O&M Calendar Year (CY), the resources required for RSN Data QA/QC during the transition to and steady-state operations. The ramp-up to steady-state level of resources (QC Analyst) for O&M is dependent on the deployment schedule for RSN instruments.

Instrument Class[1]	CY2012 QC Analyst (Hrs)	CY2013 QC Analyst (Hrs)	CY2014 QC Analyst (Hrs)	CY2014+ QC Analyst (Hrs)
ADCPS	0	260	260	260
ADCPT	208	1040	1040	1040
BOTPT	0	312	312	312
CAMHD	0	104	104	104

CAMDS	0	208	416	416
CTDPF	104	0	832	832
DOFST	52	0	208	208
DOSTA	0	0	416	416
FLOBN/OTIS	0	0	104	104
FLORD	0	0	312	312
FLORT	0	0	832	832
HPIES	0	0	208	208
HYDBB	0	0	104	104
HYDLF	0	104	130	130
MASSP	0	312	312	312
NUTNR	0	0	104	104
OBSBB	0	520	520	520
OBSSP	0	832	832	832
OPTAA	0	0	624	624
OSMOI	0	80	80	80
PARAD	0	0	104	104
PCO2W	0	0	416	416
PHSEN	0	0	832	832
PPSDN	0	0	40	40
PREST	156	468	468	468
RASFL	0	40	40	40
SPKIR	0	0	312	312
THSPH	0	208	208	208
TMPSF	0	26	26	26
TRHPH	0	156	156	156
VADCP	0	0	650	650
VEL3D	0	624	1248	1248
ZPLKS	0	0	260	260
TOTAL ANNUAL HOURS (QC ANALYST)	520	5294	12510	12510
TOTAL ANNUAL FTE[2] (QC ANALYST)	**0.3**	**2.9**	**7.0**	**7.0**

[1] Instrument classes and deployment are described below. Additional CY details can be found in RSN_BOE_Data_QAQC_Resources_2011-04-29_ver_2-00.xls

[2] FTE is based on 1800 hrs/year.

BACKGROUND

The Regional Scale Nodes network is a cabled ocean observatory. The high bandwidth and power capabilities of the system will provide virtually continuous streams of real-time data to the scientific community. The resulting large quantity and continuous nature of the data, differentiates the Data QA/QC resource needs of the RSN from those of other Implementing Organizations (IOs). Automated QC algorithms will be a significant component of the data QA process for all components of the OOI network, and it is expected that shared algorithms will be used for common and/or similar instrument classes deployed across IOs. While automation of the QC process will significantly reduce the need for manual intervention, QC inspection by human experts will be critical to ensure that automated algorithms are effective and that resulting data flags are appropriate. This "visual data QC" also provides the most up-to-date qualification of the data streams via human judgment, i.e. before automated algorithms may be appropriately updated due to changes in the instruments and/or environment being monitored. Furthermore, external calibration and validation of data streams is an important component of data quality assurance. Development of proper procedures and adequate resources for all aspects of this data assurance process will ensure that the OOI delivers a high-quality data product to the scientific community.

The estimates and basis describe the total level of effort (LOE) anticipated for Data QA/QC for instruments deployed on the RSN network only. Resource requirements are highly dependent on the level and breadth of data products that OOI will provide. There is a direct correlation between the number and complexity of the derived products and the resources needed for Data QA/QC. The estimates provided in this document are based on exemplar instruments and the most current understanding of the data products that OOI will provide to the community. This aspect of the OOI is constantly evolving, and updates to both the data product list as well as required QA/QC resources will occur during both construction and operational phases of the OOI.

These current estimates of the RSN Data QA/QC resources are independent of the models (IO-independent, cross-IO, entrainment of community experts), or combination thereof, that OOI may utilize for Data QA/QC. While the QA/QC resource requirements described herein do not preclude the use of personnel resources across IOs or external to OOI, they are independent and present the best estimates of required IO-based QA/QC personnel. Sharing of QC resources and/or entrainment of experts in the scientific community would be highly desirable from both cost savings as well as community involvement in the development of the OOI program. The employment of a model of fully or partially shared QA/QC resources (eg. cross-IO) may, in lieu of decreasing the needed personnel resources, provide an opportunity to reallocate those resources to providing a higher level and quality of data products to the community.

The development of the RSN Data QA/QC policies and procedures will use the most up-to-date established guidelines for quality assurance of real-time oceanographic data. One source of such guiding principles are the ***Quality Assurance of Real-time Oceanographic Data (QARTOD) Workshops***. A key outcome of QARTOD is the development of the **Seven Laws Of Data Management,** initially defined in the 2003 workshop and later refined:

1) Every real-time observation distributed to the ocean community must be accompanied by a quality descriptor.
2) All observations should be subject to some level of automated real-time quality test.
3) Quality flags and quality test descriptions must be sufficiently described in the accompanying metadata.
4) Observers should independently verify or calibrate a sensor before deployment.
5) Observers should describe their method/calibration in the real-time metatdata.
6) Observers should quantify the level of calibration accuracy and the associated expected error bounds.
7) Manual checks on the automated procedures, the real-time data collected and the status of the observing system must be provided by the observer on a time-scale appropriate to ensure the integrity of the observing system.

It is expected that future outcomes of the workshops will result in additional QA/QC guidance and development of instrument-specific processes acceptable to the scientific community..

DESCRIPTION

Data QA/QC Roles/Responsibilities/Activities

The RSN Data Management Team members will have the following roles and responsibilities during steady-state operations of the RSN component of OOI. The identified activities are independent of the Instrument Class. Class-dependent activities (work descriptions), if necessary, are provided in each Instrument Class Description.

DATA MANAGER/ARCHITECT:

- Manages RSN Data infrastructure and assists in hiring QC personnel and development of annual budgets.
- Oversees RSN QC analyses and allocates resources during steady-state QC activities.
- Reallocates Data QA/QC resources for ticket-resolution and/or trouble-shooting.
- Functions as primary contact between RSN Field Operations team and RSN Data QA/QC Team for Field Verification activities and transfer of analytical results and metadata into the RSN Data Calibration and Validation processes.
- Functions as primary contact between RSN Data QA/QC Team and Cyber Infrastructure (CI).
- Functions as primary contact between RSN Data QA/QC Team and the RSN Refurbishment and Calibration Group.
- Functions as primary contact between RSN Data QA/QC Team and Principal Investigators (PIs) for non-OOI instruments on the RSN network.
- Consults with RSN Science Team regarding Data Validation (incorporation of Field Verification results) procedures and policies.
- Implements Field Verification results into RSN Data Calibration and Validation processes.
- Issues Annual Report on RSN Data QA/QC activities, metrics, etc.
- Implements and/or directs implementation of changes in Data QA/QC algorithms, policies, and procedures.
- Represents RSN Data QA/QC Team in cross-IO Data QA/QC activities and policy development.
- Represents RSN Data QA/QC Team in the appropriate Subgroups of the OOI Data/Products Working Group.

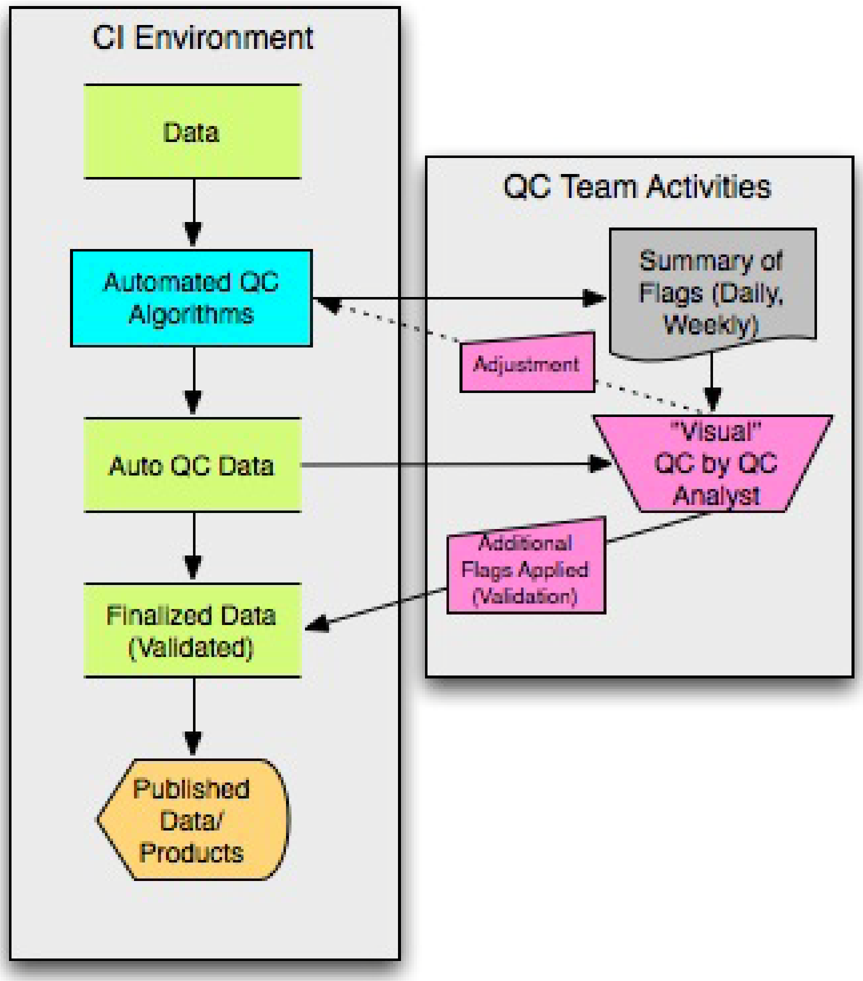
DATA QC ANALYSTS (7.0 FTE Total at Steady-State, LOE allocation by instrument as described below):

- Inspects daily and/or weekly summaries from automated QC algorithms.
- Conducts “visual” data QC inspection of actual data streams, as necessary, to resolve conditional or negative flags and monitors functioning of automated QC algorithms.
- Inspects data product outputs, i.e. checks OOI website, to ensure proper functioning of data product algorithms.
- Incorporates metadata into data repository as necessary and under the direction of the Data Manager/Architect.
- Monitors metadata accuracy and corrects as necessary.
- Creates additional flags if necessary and validates data quality.
- Uploads those additional flags and/or data validation results to CI.
- Implements data calibrations from Field Verifications into data products under the direction of the Data Manager/Architect.
- Issues trouble-tickets and resolves issues as necessary.

- Interacts with CI to ensure that automated QC algorithms are appropriately functioning and updated as required.

Data QC Process Framework

A general framework for the QC process for RSN data streams is presented in Figure 1 below.



Instrument Class–Independent Assumptions for QA/QC of Regional Scale Nodes (RSN) Data Streams

The following assumptions regarding responsibilities for **Field Verification** of instruments for inputs to Data QA/QC are valid for all of the instrument classes to be deployed on the RSN network. Class–dependent assumptions are provided, as required, in each Instrument Class description.

- Shipboard measurements of water column and seafloor parameters for ***Field Verification*** of RSN instrument data streams are performed and documented by the **RSN Field Operations Team.**
- Shipboard collection of physical samples and shipboard analyses thereof for ***Field Verification*** of RSN instrument data streams are performed and documented by the **RSN Field Operations Team**.
- Shorebased analyses of physical samples for **Field Verification** of RSN Instrument data streams are performed or contracted and subsequently documented by **the RSN Field Operations Team**.

The following assumptions regarding Data QA/QC are valid for all of the instrument classes to be deployed on the RSN network. Class–dependent assumptions are provided, as required, in each Instrument Class description. The listed assumptions include anticipated policies and procedures for data management that have not been fully defined or approved by the RSN or Ocean Leadership (OL).

- Instruments may have an internal set of calibration coefficients which the RSN procedures will not change for the duration of a single deployment.
- If necessary, RSN will apply a set of external calibration equations/coefficients, which are applied to data that already is in physical units and represent a small correction to these data (e.g. a computationally simple gain & offset correction).
- The external calibration parameters will be determined during Field Verification procedures conducted by the RSN Field Operations Team. These procedures may consist of a post-deployment measurement, pre-recovery measurement, or both. Measurements include shipboard or ROV data collection and chemical analyses, physical sample collection and shipboard chemical analyses, and post-cruise shore-based analyses. If external calibration is deemed necessary for an instrument, it will be applied to the data over the deployment duration such that the to-be-applied correction is interpolated in time appropriately between post-deployment and pre-recovery calibrations.
- Automated data QC algorithms will generate “QC flags” (numbers or letters characterizing data quality) for each data point and associate them with the data. These algorithms are defined during the construction phase of the OOI and reside in the CI computing environment.
- “Visual” data QC procedures means inspection by a human expert who inspects the data and the output of the automated QC algorithms, and generates a set of QC flags based on his/her judgment of the data.

Instrument Class ADCPS

The Acoustic Doppler Current Profiler, 75 kHz (ADCPS) is used to measure the mean water velocity profiles in the 600-700 m range.

Number Deployed: 1

Location of Deployment: Southern Hydrate Summit, 811 m depth (1).

Data/Products: Mean water velocity profiles in 600-700 m range.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 5 hours/week per instrument (**0.14 FTE Total**).

Basis of Estimate: Initial estimate, based on discussions with D. Luther (Physical Oceanographer, University of Hawaii), was 1 hr/week for each of 8 raw data streams (total 8 hrs/week per instrument) in order to produce highest quality high-level derived data products. Due to cost constraints, estimate was reduced to 5 hrs/week.

Using that 5/hrs week estimate as a basis for all ADCP (including VADCP) types and deployments results in a 1.1 FTE for the total level of effort across RSN. This is consistent with the suggestion by Paul Freitag (TAO Data Manager) who estimated that approximately 1.0 FTE would be needed for all of RSN.

Instrument Class ADCPT

The Acoustic Doppler Current Profiler, 150 kHz (ADCPT) is used to measure the mean water velocity profiles in the 300 m range.

Number Deployed: 4

Location of Deployment: Hydrate Ridge, 200 m platform (1); Southern Hydrate Summit, 807 m depth (1); Axial Seamount, 2597 m (1); Axial Seamount, 200 m platform (1).

Data Products: Mean water velocity profiles in 300 m range.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 5 hours/week per instrument (**0.58 FTE Total**).

Basis of Estimate: Initial estimate, based on discussions with D. Luther (Physical Oceanographer, University of Hawaii), was 1 hr/week for each of 8 raw data streams (total 8 hrs/week per instrument) in order to produce highest quality high-level derived data products. Due to cost constraints, estimate was reduced to 5 hrs/week.

Using that 5 hrs/week estimate as a basis for all ADCP (including VADCP) types and deployments results in a 1.1 FTE for the total level of effort across RSN. This is consistent with the suggestion by Paul Freitag (TAO Data Manager) who estimated that approximately 1.0 FTE would be needed for all of RSN.

Instrument Class BOTPT

The Bottom Pressure and Tilt Instrument (BOTPT) is a core, non-commercial (PI) instrument that will be used to derive seafloor uplift/deflation.

Number Deployed: 3

Location of Deployment: Axial Seamount - N.Caldera, 1584 m (1); E.Caldera / Slope,1518 m (1); "Seismic" Area, 1554 m (1).

Data Products: Seafloor tilt, bottom pressure at seafloor; derived seafloor uplift/deflation.

Class-specific Assumptions: None

Class-specific Work Description: Derivation of seafloor uplift/deflation will require close collaboration with Principal Investigator (PI) and detailed examination and interpretation of data streams.

Resource Estimate: 2.0 hrs/week per instrument (**0.17 FTE Total**).

Basis of Estimate: The instrument's Principal Investigator (PI) Bill Chadwick (Oregon State University, PMEL) estimated that ~ 5 hr/week for raw data streams of all 3 instruments combined. The estimate was increased to a total of 6 hrs/week for the 3 instruments combined to allow for collaborative derivation of the final desired Level 2 data product.

Instrument Class CAMHD

The HD Video camera (CAMHD) is used to obtain HD video images.

Number Deployed: 1

Location of Deployment: Axial Seamount, "Inferno", 1551 m.

Data Products: HD Video imagery.

Class-specific Assumptions: None

Class-specific Work Description: HD Video will be checked and comments on quality will be recorded as required and resources allow. Lighting will be checked. Pan/tilt will be exercised and its functioning evaluated.

Resource Estimate: 2.0 hrs/week per instrument (**0.06 FTE Total**).

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class CAMDS

The digital still camera (CAMDS) is used to obtain still imagery.

Number Deployed: 4

Location of Deployment: Hydrate Ridge, 200 m platform (1); Southern Hydrate Summit, 811 m (1); Axial Seamount, “Diffuse” Site, 1552 m; Axial Seamount, 200 m platform (1)

Data Products: Digital still imagery.

Class-Specific Assumptions: None

Class-specific Work Description: Still imagery will be checked and comments on quality will be recorded as required and resources allow. Lighting will be checked. Pan/tilt will be exercised and its functioning evaluated.

Resource Estimate: 2.0 hrs/week per instrument (**0.23 FTE Total**).

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class CTDPF

The Conductivity, Temperature, Depth (CTDPF) Instrument is used to obtain temperature, salinity, and density profiles.

Number Deployed: 8

Location of Deployment: Multiple locations on RSN cabled network.

Data Products: Conductivity, temperature, pressure (depth); derived salinity, density.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.0 hrs/week per instrument (**0.46 FTE Total**)

Basis of Estimate: Initial estimate, based on discussions with D. Luther (Physical Oceanographer, University of Hawaii), was 1 hr/week for each of 3 raw data streams (CTD, excluding time) resulting in total 3 hrs/week per instrument in order to produce highest quality high-level derived data products.

Marlene Jeffries (Primary Data QA/QC Analyst for VENUS) estimated that with automated QC algorithms in place, it takes ~ 0.25 hr/day per instrument (1.25 hrs/week) for manual QC analysis of VENUS deployed CTDs, not including troubleshooting significant problems.

In order to include troubleshooting effort and the original higher estimate for high quality high-level data products, a compromise of 2.0 hrs/week per instrument has been utilized.

Instrument Class DOFST

The Dissolved Oxygen, Fast Response (DOFST) Instrument is used to make rapid measurements of dissolved oxygen in the water column.

Number Deployed: 4

Location of Deployment: Hydrate Ridge, Shallow Profiler (1); Hydrate Ridge, Deep Profiler (1); Axial Seamount, Shallow Profiler (1); Axial Seamount, Deep Profiler (1)

Data Products: Oxygen concentration in water.

Class-Specific Assumptions: None

Class-specific Work Description: DOFST measurement accuracy may be checked and calibrated using DOSTA (see below) Instrument.

Resource Estimate: 1.0 hrs/week per instrument **(0.12 FTE Total)**

Basis of Estimate: Marlene Jeffries (Primary Data QA/QC Analyst for VENUS) stated that before VENUS implemented automated QC algorithms, it would take ~ 2 hrs/week per instrument. Assuming that automation would save *at least* half the LOE and adding additional effort for cross-checking and potential calibration using collocated DOSTA Instrument results in an effort of 1.0 hrs/ week.

Instrument Class DOSTA

The Dissolved Oxygen, Stable Response (DOFST) Instrument is used to make stable measurements of dissolved oxygen in the water column.

Number Deployed: 8

Location of Deployment: Multiple locations on RSN cabled network.

Data Products: Oxygen concentration in water.

Class-specific Assumptions: None

Class-specific Work Description: DOSTA may also be used to check and calibrate the DOFST (see above) Instrument.

Resource Estimate: 1.0 hrs/week per instrument **(0.23 FTE Total)**

Basis of Estimate: Marlene Jeffries (Primary Data QA/QC Analyst for VENUS) stated that before VENUS implemented automated QC algorithms, it would take ~ 2 hrs/week per instrument. Assuming that automation would save *at least* half the LOE and adding additional effort for using these instrument to cross-check and potentially calibrate collocated DOFST Instrument results in an effort of 1.0 hrs/ week.

Instrument Class FLOBN (formerly OTIS)

The Flow Sensor (FLOBN) Instrument is a core, non-commercial (PI) instrument used to make fluid flow measurements at the sediment-water interface.

Number Deployed: 1

Location of Deployment: Southern Hydrate Summit, 811 m

Data Products: Fluid flow rate time-series.

Class-Specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.0 hrs/week per instrument **(0.06 FTE Total)**

Basis of Estimate: The LOE required for QC of this instrument type is highly dependent on the nature of the sensing system, which is yet to be determined. Thermal-based flow measurements are used for this initial estimate, but the LOE is likely to change as the instrument design matures.

Instrument Class FLORD

The Fluorometer, 2-wavelength (FLORD) is used to obtain measurements of chlorophyll and optical backscatter in the water column.

Number Deployed: 2

Location of Deployment: Hydrate Ridge, 200 m platform (1); Axial Seamount, 200 m platform (1)

Data Products: Chlorphyll-a, optical backscatter

Class-Specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 3.0 hrs/week per instrument **(0.17 FTE Total)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class FLORT

The Fluorometer, 3-wavelength (FLORT) is used to obtain measurements of chlorophyll, optical backscatter, and CDOM fluorescence in the water column.

Number Deployed: 4

Location of Deployment: Hydrate Ridge, Deep Profiler (1); Hydrate Ridge, Shallow Profiler (1); Axial Seamount, Deep Profiler (1); Axial Seamount, Shallow Profiler (1)

Data Products: Chlorophyll-a, optical backscatter, CDOM fluorescence

Class-Specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 4.0 hrs/week per instrument **(0.46 FTE Total)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class HPIES

The Horizontal Electrometer-Pressure-Inverted Echosounder (HPIES) is a core, non-commercial (PI) Instrument which is used to measure simultaneously bottom pressure, seafloor to sea surface acoustic travel time (RATT) and motionally-induced electric fields.

Number Deployed: 2

Location of Deployment: Hydrate Ridge, 2906 m (1); Axial Seamount, 2597 m (1)

Data Products: RATT, bottom pressure, horizontal electric fields.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.0 hrs/week per instrument **(0.12 FTE Total)**

Basis of Estimate: Tom Sanford (UW-APL), designer of HPIES, estimated that low-level QC of HPIES data would require approximately 2 hrs/week per instrument.

Instrument Class HYDBB

The APL passive broadband hydrophone (HYDBB) Instrument is used to measure acoustic pressure waves (marine mammals, fish)

Number Deployed: 4

Location of Deployment: Hydrate Ridge, 2906 m (1); Hydrate Ridge, 200 m platform (1); Axial Seamount, 2597 m (1); Axial Seamount, 200 m platform (1)

Data Products: Acoustic pressure waves; broadband passive acoustics.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 0.50 hrs/week per instrument **(0.06 Total)**

Basis of Estimate: S. Denny of UW-APL provided the estimate of QC time for hydrophone data based on his history with hydrophone group at APL.

Instrument Class HYDLF

The APL low frequency hydrophone (LF) Instrument is used to measure acoustic backscatter

Number Deployed: 5

Location of Deployment: Hydrate Ridge, 2909 m (1); Southern Hydrate Summit, 807 m (1); Axial Seamount, 2654 m (1); Axial Seamount, Eastern Caldera, 1518 m (1); Axial Seamount, Northern Caldera, 1584 m (1)

Data Products: Acoustic pressure waves/backscatter.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 0.5 hrs/week per instrument **(0.07 Total FTE)**

Basis of Estimate: S. Denny of UW-APL provided the estimate of QC time for hydrophone data based on his history with hydrophone group at APL.

Instrument Class MASSP

The Mass Spectrometer (MASSP) Instrument is used to measure dissolved gases in situ at the seabed.

Number Deployed: 2

Location of Deployment: Southern Hydrate Summit, 811 m (1); Axial Seamount, Diffuse Site 1552 m (1)

Data Products: Concentrations of dissolved gases (C1-C5 alkanes, H2, O2, N2,H2S, Ar, CO2) at the seabed.

Class-specific Assumptions: None

Class-specific Work Description: In addition to monitoring mass peak calibrations and intensities, transformations of integrated areas into concentrations will require extensive manual application of calibration schemes on a weekly basis.

Resource Estimate: 3.0 hrs/week per instrument **(0.17 Total FTE)**

Basis of Estimate: The LOE required is based on O. E. Kawka’s (RSN Project Scientist) extensive background in mass spectrometry and analytical and quantitative techniques.

Instrument Class NUTNR

The Nutrient Nitrate (NUTNR) Instrument is used to measure nitrate concentration in the seawater.

Number Deployed: 2

Location of Deployment: Hydrate Ridge, Shallow Profiler (1); Axial Seamount, Shallow Profiler (1)

Data Products: Nitrate concentration.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 1.0 hrs/week per instrument **(0.06 Total FTE)**

Basis of Estimate: Ken Johnson of MBARI estimated that, provided the automated QC algorithms were well implemented and data offset correction already applied, the manual QC portion would require ~ 0.5 days/month. This is consistent with the original estimate.

Instrument Class OBSBB

The broadband triaxial seismometer (OBSBB) Instrument is used to measure broadband ground motion.

Number Deployed: 5

Location of Deployment: Hydrate Ridge, 2909 m (1); Southern Hydrate Summit, 807 m (1); Axial Seamount, 2654 m (1); Axial – Northern Caldera, 1584 m (1); Axial – Eastern Caldera/Slope, 1518 m (1).

Data Products: Velocity, acceleration; broadband ground motion, strong motion.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.0 hrs/week per instrument **(0.29 Total FTE)**

Basis of Estimate: Frank Vernon (Geophysicist, SIO) estimated that, provided automated QC algorithms were implemented, ~ 4 hrs/week for all seismometers (5 broadband tri-axial and 8 short period) would be needed to generate simple seismic time series. He also estimated that generating advanced data products (Level 2) would require 2 days/week of an expert seismic analyst (16 hrs/week in total).

The current estimate assumes a non-expert seismic analyst (~26 hrs/week total) and/or contracting out the analyses to a relevant seismic network or to ANF (USArray).

Instrument Class OBSSP

The short-period seismometer (OBSSP) Instrument is used to measure short-period ground motion.

Number Deployed: 8

Location of Deployment: Southern Hydrate Summit, 807 m (3); Axial Seamount, “Seismic” Area, 1554 m (4); Axial Seamount, Northern Caldera, 1584 m (1)

Data Products: Velocity; short-period ground motion.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.0 hrs/week per instrument **(0.46 Total FTE)**

Basis of Estimate: Frank Vernon (Geophysicist, SIO) estimated that, provided automated QC algorithms were implemented, ~ 4 hrs/week for all seismometers (5 broadband tri-axial and 8 short period) would be needed to generate simple seismic time series. He also estimated that generating advanced data products (Level 2) would require 2 days/week of an expert seismic analyst (16 hrs/week in total).

The current estimate assumes a non-expert seismic analyst (~26 hrs/week total) and/or contracting out the analyses to a relevant seismic network or to ANF (USArray).

Instrument Class OPTAA

The optical attenuation and absorption (OPTA) Instrument is used to measure the optical properties of the water column

Number Deployed: 6

Location of Deployment: Hydrate Ridge, 2906 m (1); Hydrate Ridge, Deep Profiler (1); Hydrate Ridge, Shallow Profiler (1); Axial Seamount, 2597 m (1);Axial Seamount, Deep Profiler (1); Axial Seamount, Shallow Profiler (1)

Data Products: Optical attenuation, optical absorption.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.0 hrs/week per instrument **(0.35 Total FTE)**

Basis of Estimate: Oscar Schofield (Rutgers University) concurred with the above initial estimate, provided automated QC algorithms are also implemented.

Instrument Class OSMOI

The In situ Osmotic Water Sampler (OSMOI) Instrument is a core, non-commercial (PI) Instrument which is used to continuously collect a yearlong series of fluid samples for later chemical analysis.

Number Deployed: 2

Location of Deployment: Southern Hydrate Summit, 811 m (1); Axial Seamount, Diffuse Site, 1552 m (1).

Data Products: Physical water sample for major/trace element chemistry.

Class-specific Assumptions: None

Class-specific Work Description: The Instrument will be recovered annually and the fluid samples will be analyzed. The chemical analysis results will undergo QA/QC (~ 1 week of work)

Resource Estimate: 0.77 hrs/week per instrument **(0.04 Total FTE)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) regarding the necessary analytical requirements and the LOE for QA/QC of the results.

Instrument Class PARAD

The Photosynthetically Active Radiation (PARAD) Instrument is used to measure the amount of radiation in the water column critical for photosynthesis (PAR).

Number Deployed: 2

Location of Deployment: Hydrate Ridge, Shallow Profiler (1); Axial Seamount, Shallow Profiler (1).

Data Products: Photosynthetically Active Radiation (PAR)

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 1.0 hrs/week per instrument **(0.06 Total FTE)**

Basis of Estimate: Oscar Schofield (Rutgers University) concurred with the above initial estimate, provided automated QC algorithms are also implemented.

Instrument Class PCO2W

The Partial Pressure of CO_2 in Water (PCO2W) Instrument is used to measure the concentration of CO_2 in the water column.

Number Deployed: 2

Location of Deployment: Hydrate Ridge, Shallow Profiler (1); Axial Seamount, Shallow Profiler (1).

Data Products: pCO2

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 4.0 hrs/week per instrument **(0.46 Total FTE)**

Basis of Estimate: C. Sabine of NOAA/PMEL concurs with the estimate of LOE provided that automated QC algorithms are in place.

Instrument Class PHSEN

The Total pH, stable response (PHSEN) Instrument is used to measure the pH in the water column.

Number Deployed: 4

Location of Deployment: Hydrate Ridge, 200 m platform (1); Hydrate Ridge, Shallow Profiler (1); Axial Seamount, 200 m platform; Axial Seamount, Shallow Profiler (1).

Data Products: Total pH

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 4.0 hrs/week per instrument **(0.46 Total FTE)**

Basis of Estimate: C. Sabine of NOAA/PMEL concurs with the estimate of LOE provided that automated QC algorithms are in place.

Instrument Class PPSDN

The Phytoplankton Particulate Sampler DNA (PPSDN) is a core, non-commercial (PI) Instrument which collects physical samples for later microbial DNA analyses.

Number Deployed: 1

Location of Deployment: Axial Seamount, Diffuse Site, 1552 m

Data Products: Physical particulate samples for microbial DNA analyses.

Class-specific Assumptions: None

Class-specific Work Description: The Instrument will be recovered annually and the particulate samples will be analyzed. The DNA results will be processed (~1 week of QA/QC work).

Resource Estimate: 0.77 hrs/week per instrument **(0.04 Total FTE)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) regarding the necessary analytical requirements and the LOE for QA/QC of the results.

Instrument Class PREST

The Seafloor Pressure, Tidal (PREST) Instrument measures the bottom pressure at the seafloor deployment location

Number Deployed: 3

Location of Deployment: Hydrate Ridge, 2909 m (1); Southern Hydrate Summit, 807 m (1); Axial Seamount, 2654 m (1)

Data Products: Pressure, temperature.

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 3.0 hrs/week per instrument **(0.26 Total FTE)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class RASFL

The Remote Access Fluid Sampler (RASFL) Instrument is a core, non-commercial (PI) Instrument which collects physical samples of vent fluids for later chemical analyses

Number Deployed: 1

Location of Deployment: Axial Seamount, Diffuse Site 1552 m

Data Products: Physical Fluid samples for major and minor ionic species analyses.

Class-specific Assumptions: None

Class-specific Work Description: The Instrument will be recovered annually and the fluid samples will be analyzed. The chemical analysis results will undergo QA/QC (~ 1 week of work)

Resource Estimate: 0.77 hrs/week per instrument **(0.04 Total FTE)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) regarding the necessary analytical requirements and the LOE for QA/QC of the results.

Instrument Class SPKIR

The Spectral Irradiation (SPKIR) Instrument measures the downwelling spectral irradiance.

Number Deployed: 2

Location of Deployment: Hydrate Ridge, Shallow Profiler (1); Axial Seamount, Shallow Profiler (1)

Data Products: Downwelling spectral irradiance

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 3.0 hrs/week per instrument **(0.17 Total FTE)**

Basis of Estimate: Oscar Schofield (Rutgers University) concurred with the above initial estimate, provided automated QC algorithms are also implemented.

Instrument Class THSPH

The In situ Vent Fluid pH-H_2S-H_2 (THSPH) is a core, non-commercial (PI) Instrument which measures T, pH, H_2S in situ at actively venting hydrothermal vent sites.

Number Deployed: 1

Location of Deployment: Axial Seamount, Inferno, 1551 m

Data Products: Temperature, pH, H_2S

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 4.0 hrs/week per instrument **(0.12 Total FTE)**

Basis of Estimate: The above estimate is based on advice received from the Instrument PI (Marv Lilly, School of Oceanography – UW) regarding the LOE that will be needed for the QA/QC of the instrument.

Instrument Class TMPSF

The Thermistor Array (TMPSF) Instrument is a core, non-commercial (PI) Instrument which measures diffuse heat flux at the sea floor.

Number Deployed: 1

Location of Deployment: Axial Seamount, Diffuse, 1552 m

Data Products: Temperature gradient, diffuse flow

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 0.5 hrs/week per instrument **(0.01 Total FTE)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class TRHPH

The Res Probe (TRHPH) Instrument is a core, non-commercial (PI) Insturment which makes in situ measurements of temperature, chloride,and hydrogen concentration in black smokers on the seafloor.

Number Deployed: 1

Location of Deployment: Axial Seamount, Inferno, 1551 m

Data Products: Temperature, chloride and hydrogen concentrations

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 3.0 hrs/week per instrument **(0.09 Total FTE)**

Basis of Estimate: This estimate was based on discussions and a consensus between field-experienced RSN Project Scientists O. E. Kawka and G. Proskurowski (School of Oceanography-UW) and Senior Ocean Engineer S. Denny (APL-UW).

Instrument Class VADCP

The 5-Beam Acoustic Doppler Current Profiler, 300 kHz (VADCP) is used to measure the turbulent water velocity profiles.

Number Deployed: 2

Location of Deployment: Hydrate Ridge, 200 m platform; (1); Axial Seamount, 200 m platform

Data Products: Velocity profiles, acoustic backscatter, orientation (pitch, roll, heading)

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 6.25 hrs/week per instrument **(0.36 Total FTE)**

Basis of Estimate: Initial estimate, based on discussions with D. Luther (Physical Oceanographer, University of Hawaii), was 1 hr/week for each of 8 raw data streams (total 8 hrs/week per instrument) on an ADCP in order to produce highest quality high-level derived data products. Due to cost constraints, estimate was reduced to 5 hrs/week. For this VADCP, a multiplicative factor of 1.25 was used for estimating the LOE.

Using that 5/hrs week estimate as a basis for all ADCP (including VADCP) types and deployments results in a 1.1 FTE for the total level of effort across RSN. This is consistent with the suggestion by Paul Freitag (TAO Data Manager) who estimated that approximately 1.0 FTE would be needed for all of RSN.

Instrument Class VEL3D

The 3-D Acoustic Current Meter (VEL3D) Instrument measures 3-D single point current velocities.

Number Deployed: 8

Location of Deployment: Multiple locations of the RSN observatory network.

Data Products: Velocity (3-D), acoustic backscatter, orientation (pitch, roll, heading)

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 3.0 hrs/week per instrument **(0.69 Total FTE)**

Basis of Estimate: Estimated based on 4 paths x 0.75 hr/week and consistency with ADCPs and VADCPs

Instrument Class ZPLKS

The Zooplankton/Plankton Sonar (ZPLKS) Instrument measures the water column distribution of zooplankton and fish as indicated by their acoustic backscatter.

Number Deployed: 2

Location of Deployment: Locations on the RSN observatory network to be determined.

Data Products: Acoustic backscatter

Class-specific Assumptions: None

Class-specific Work Description: None

Resource Estimate: 2.5 hrs/week per instrument **(0.14 Total FTE)**

Basis of Estimate: Discussion on 4/21/11 with John K. Horne (UW School of Fisheries), - He has deployed similar instrument on MARS and suggested that 5 hours a week for 2 instruments would allow manual QC of flagged data (automated QC algorithms) and production of reasonable product for the community.

2) BASIS OF ESTIMATE FOR RSN METADATA MANAGEMENT

INTRODUCTION

Shipboard and shore-based activities of the RSN Program during operations will result in the creation of large amounts of data and metadata for and about the RSN network and core instruments. This data and metadata are critical to the overall OOI Program and will include those derived from and/or documenting:

1) Verification of instruments before deployment and after recovery,
2) Deployment and recovery of instruments and other RSN infrastructure,
3) Field verification of RSN data streams post-deployment and pre-recovery,
4) Cataloging and preserving/archiving of physical samples from core OOI instruments,
5) Cataloging and preserving/archiving physical samples for field verification of RSN data streams,
6) Shipboard and shore-based analysis of physical samples for field verification of RSN data streams,
7) Shipboard and shore-based analysis of physical samples for calibration of RSN data stream,
8) Shore-based analysis of physical samples from core OOI instruments, and
9) Shipboard maintenance of the RSN observatory network infrastructure and core instruments.

RSN METADATA MANAGEMENT SUMMARY INFORMATION

Members of the RSN Science and Engineering Staff that will be active in the RSN Metadata Management include:

- UW Associate Director for Science
- UW APL Senior Ocean Engineer
- UW Data Manager/Architect
- UW Junior Project Scientists
- UW Science Technician
- UW Undergraduate Students

These individuals will ensure the integrity of the RSN data and metadata generated during shipboard and shore-based activities; that all data and metadata are properly transferred to the CI environment; and that the data and metadata are properly incorporated into the Data Calibration/Validation and QA/QC processes for the RSN instruments.

Basis of Estimate: The proportion of the RSN Data Management resources required for the activities associated with the Task (RSN Metadata Management) is based on RSN senior scientific and engineering staff's ***extensive shipboard and data management experience***.

3) BASIS OF ESTIMATE FOR O&M DATA PRODUCT MANAGEMENT SUBGROUP

INTRODUCTION

The O&M Data Product Management Subgroup (DPMSG) is responsible for identifying/defining the data and data product management requirements and processes of the OOI in the operational phase of the project. These processes will ensure data quality and product availability, as per the OOI documents, and the ability to adapt the OOI data products to evolving science needs as applicable. The activities of the DPMSG will facilitate the **transition** from construction phase to operations phase for data products management. During the operational phase of the OOI Program, the DPMSG will play a critical role in the Data Products Working Group and its continuing activities will ensure a coherent strategy for the application, review, and necessary updating of the OOI data products policies and procedures.

The O&M DPMSG will have a variety of duties including, but not limited to:

1) Assisting with the OOI Data Management Plan,
2) Developing and maintaining the OOI Data Product Catalog,
3) Assisting with the maintenance of the OOI Data Product Algorithms and Documentation,
4) Assisting with the maintenance and improvement of the OOI Data Product QA/QC Calibration/Validation procedures and algorithms, and
5) Assisting with the maintenance of the OOI Sampling Strategy Plan.

O&M DPMSG SUMMARY INFORMATION

Members of the RSN Science Staff, including a Senior and Junior Project Scientist (co-lead of the subgroup), will be highly active in the O&M Data Product Management Subgroup. In addition to this high-level of direct group participation, their activities during the transition to operations will also include:

- Participating and preparing for the quarterly O&M meetings and
- Assisting in the development of deliverable for Data Product Management during construction – ensuring that operational aspect is fully covered in documents associated with deliverables.

After the completion of the Construction Phase, the activities of the RSN members of the O&M DPMSG will focus on the following areas:

- Annual review of OOI Data Management Plan,
- Annual review of the OOI Data Product List,
- Semiannual Review of OOI Data Production Algorithms,
- Semiannual Review of QA/QC and Data Calibration/Validation Procedures & Algorithms,
- Annual Review of the OOI Sampling Strategy Plan, and
- Annual Report on Community Needs for above items.

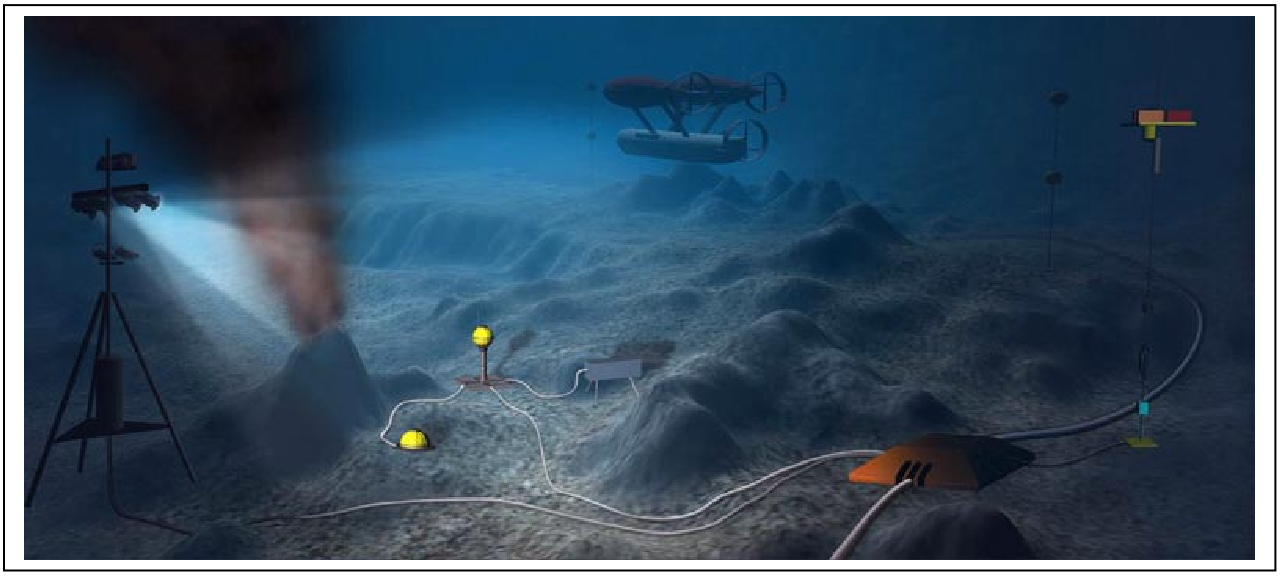
Basis of Estimate: The proportion of the RSN Data Management resources required for the activities associated with the Task (O&M Data Products Management Subgroup) is based on ***historical data*** for level of effort and travel associated with past OOI quarterly O&M meetings; level of effort associated with the development and review of OOI data and data product policies, procedures, and documentation; and the anticipated ramp-up in OOI-wide data product management activities.

Notes to Right and Below				Taken from Skip-generated speadsheet: RSN CGSN Revised Combined Core Sensor List ver 1.2	Taken from Skip-generated speadsheet: RSN CGSN Revised Combined Core Sensor List ver 1.2	Total Number of Instruments	DATA PRODUCTS	DATA VARIABLES	2012 QA/QC			2012 TOTAL QA/QC Hrs/week	2012 Comments	2013 QA/QC			2013 TOTAL QA/QC Hrs/week	2013 Comments	2014 QA/QC			2014 TOTAL QA/QC Hrs/week	2014 Comments	After 2014 QA/QC			After 2014 TOTAL QA/QC Hrs/week	After 2014 Comments	GENERAL COMMENTS FOR GUIDANCE
Column Headers =>	Mulitples?	Name	Description	Calibration Cycle	Lifetime Expectancy	RSN Deployed (from DPs ss)	from DP SS	from DP SS	Auto QC	Manual QC Hrs/week/inst	2012 RSN Deployed			Auto QC	Manual QC Hrs/week/inst	2013 RSN Deployed			Auto QC	Manual QC Hrs/week/inst	2014 RSN Deployed			Auto QC	Manual QC Hrs/week/inst	2014+ RSN Deployed			
1Hz ping rate typical		ADCPS	RDI Longranger ADCP 75KhZ	3 years	10 years	1	Mean Water Velocity Profiles (600-700m range)	1) Velocity Profiles 2) Acoustic Backscatter 3) Orientation							5.0	1	5.0	Hydrate Summit D.Luther suggested 8 (8 streams x1 hr/wk)		5.0	1	5.0	Hydrate Summit D.Luther suggested 8 (8 streams x1 hr/wk)		5.0	1	5.0	Hydrate Summit D.Luther suggested 8 (8 streams x1 hr/wk)	2011-03-21 OEK consulted Paul Freitag (TAO Data Manager - lots of experience w/ ADCP QA/QC) - Based on the total number of ADCPs and VADCPs, thought we would need approx. one full-time person. Compare it with our 37.5 hrs/ week
1Hz ping rate typical		ADCPT	RDI Quartermaster ADCP 150kHz	3 years	10 years	4	Mean Water Velocity Profile (300 m range)	1) Velocity Profiles 2) Acoustic Backscatter 3) Orientation		4.0	1	4.0	D. Luther suggested 0.20 (8 streams x 0.025); NC has max 6 streams		5.0	4	20.0	D. Luther suggested 8 (8 streams x 1 hr/wk); NC has max 6 streams		5.0	4	20.0	D. Luther suggested 8 (8 streams x 1 hr/wk); NC has max 6 streams		5.0	4	20.0	DL suggested 8 (8 streams x 1 hr/wk); NC has max 6 streams	2011-03-21 OEK consulted Paul Freitag (TAO Data Manager - lots of experience w/ ADCP QA/QC) - Based on the total number of ADCPs and VADCPs, thought we would need approx. one full-time person. Compare it with our 37.5 hrs/week estimate.
		BOTPT	GeoMechanics LILY Self-Leveling Borehold Tiltmeter and temperature sensor, paired with ParoSci pressure sensor, see PREST	5 years	10 years	3	floor Inflation/Deflat	X Tilt Y Tilt Pressure							2.0	3	6.0	based on PI Chadwick ~ 1hr /day for raw streams for all 3 combined - plus a bit more (1 hr/week) for derived product check.		2.0	3	6.0	based on PI Chadwick ~ 1hr /day for raw streams for all 3 combined - plus a bit more (1 hr/week) for derived product check.		2.0	3	6.0	based on PI Chadwick ~ 1hr /day for raw streams for all 3 combined - plus a bit more 1 hr/week) for derived product.	
Suitable COTS interface hardware does not exist.		CAMHD	HD Video, Insite Pacific Zeus	Annual	3 years (technology)	1	HD Video Image	1) Lossless Compression 2)Lossy Compression							2.0	1	2.0	Exercise Pan/tilt,check video		2.0	1	2.0	Exercise Pan/tilt,check video		2.0	1	2.0	Exercise Pan/tilt,check video	
		CAMDS	Digital Stills, Prosilica GE2040 4 Megapixel	Annual	5 years	4	Still Imagery	1) Lossless Compression 2)Lossy Compression							2.0	2	4.0	Exercise Pan/tilt,check video, comment on lighting/picture quality		2.0	4	8.0	Exercise Pan/tilt,check video, comment on lighting/picture quality		2.0	4	8.0	Exercise Pan/tilt,check video, comment on lighting/picture quality	
		CTDPF	Seabird moored profiler CTD 52-MP	Annual	10 years	8	Conductivity Temperature Pressure	Conductivity Temperature Pressure		2.0	1	2.0	Originally 1 hr/week C,T,D as per D. Luther (OEK ignoring time)			0				2.0	8	16.0	Originally 1 hr/week C,T,D as per D. Luther (OEK ignoring time)		2.0	8	16.0	Originally 1 hr/week C,T,D as per D. Luther (OEK ignoring time)	Marlene Jeffries (VENUS) with auto QC ~ 0.25 hrs/day for each CTD plus a bit more for trouble. . Translates to ~ 1.25 hrs/week per CTD.. OEK increased to 2.0 hrs/week per instrument
Piggybacks on the CTDPF		DOFST	Dissolved oxygen Seabird 43-F for CTD	Annual	5 years	4	Oxygen Concentration	Oxygen Concentration		1.0	1	1.0				0				1.0	4	4.0	comparison w/slow		1.0	4	4.0	comparison w/slow	Marlene Jeffries (VENUS) before auto QC ~2.5 hrs/day for 6 sensors. Translates to ~ 2hrs/week per sensor. OEK Assuming 1/2 that once automated since DOSTA/DOFST will be compared.
		DOSTA	Dissolved oxygen, Optode, faster than Seabird	Annual	5 years	8	Oxygen Concentration	Oxygen Concentration												1.0	8	8.0	comparison w/ fast		1.0	8	8.0	comparison w/ fast	Marlene Jeffries (VENUS) before auto QC ~2.5 hrs/day for 6 sensors. Translates to ~ 2hrs/week per sensor. OEK Assuming 1/2 that once automated since DOSTA/DOFST will be compared.
		FLOBN/ OTIS	measures flow through sediment-water interface through injection of an optical tracer dye	Annual	Unknown	1	Fluid flow benthic seep sites	Flow Rate Time-series												2.0	1	2.0			2.0	1	2.0		
0.075		FLORD	Fluorometer -OB: WetLabs ECO-BB2F: fluorescence, Chl-a, optical backscatter	Annual	5 years	2 (decreased from 4)	Chlorophyll-a fluorescence Optical Backscatter	Chlorophyll-a fluorescence Opt backscatter (red)												3.0	2	6.0			3.0	2	6.0		
		FLORT	Fluorometer -3 wavelength: Eco-puck triplet: fluorescence, Chl-a, CDOM, optical backscatter	Annual	5 years	4	Chlorophyll-a fluorescence Optical Backscatter CDOM fluorescence	Chlorophyll-a fluorescence CDOM fluorescence Optical backscatter (red)												4.0	4	16.0			4.0	4	16.0		
Remarkable PI Instrument		HPIES	3D electric field sensor, as sensitive as a hammerhead shark (!)	6 months	10 years	2	RATT + Additional (May ECR)	RATT Bot Pressure Horz. electric fields												2.0	2	4.0	2 hours/week/instrument as per Tom Sanford (low-level QC)		2.0	2	4.0	2 hours/week/instrument as per Tom Sanford (low-level QC)	
300kHz BW of interest		HYDBB	APL broadband hydrophone: Naxys eHyd	5 years	10 years	4	BB passive acoustics	Acoustic pressure waves												0.5	4	2.0			0.5	4	2.0		
		HYDLF	APL low freq hydrophone			5	Aoustic backscatter	Acoustic pressure waves							0.400	5	2.0			0.5	5	2.5			0.5	5	2.5		
		MASSP	Mass Spectrometer: Stanford Research Systems RGS200 quadrupole mass spec	Annual	5 years	2	Vent fluid Chemistry Seep fluid chemistry	Partial Pressure vs Mass????							3.0	2	6.0	Based on O.E. Kawka research		3.0	2	6.0	Based on O.E. Kawka research		3.0	2	6.0	Based on O.E. Kawka research	
		NUTNR	Satlantic ISUS V3 Nitrate	Annual	5 years	2	Nitrate	Nitrate Conc												1.0	2	2.0	MBARI Ken Johnson 0.5 days/month if QC software is good and offset is applied		1.0	2	2.0	MBARI Ken Johnson 0.5 days/month if QC software is good and offset applied.	
Uses Quantera Data Logger Q330	Two Alternate Possibilities	OBSBB	Broadband Triaxial Seismometer	5 years	10 years	5	BB Ground Motiion Strong Motion	Velocity Acceleration							2.0	5	10.0			2.0	5	10.0			2.0	5	10.0		Recommendation form F. Vernon - Assuming automated algorithm, ~ 4 hrs/ week for all seismometers together would be needed for simple seismic time series.. For advanced data product s(including Level 2) 2 days/week of expert seismic analyst (16 hrs/week). OEK assuming non-expert seismic analyst (~26 hrs/week total) and or farming out to relevant seismic network or to ANF (USArray).
		OBSSP	Short Period Seismometer, MBARI/GEOSense,	5 years	10 years	8	Short Period Ground Motion	Velocity							2.0	8	16.0			2.0	8	16.0			2.0	8	16.0		
		OPTAA	Optical Attenuation: AC-s	Annual	5 years	6	Optical Attenuation Optical Absorption	Opt Atten Opt Abs								0				2.0	6	12.0	Concurrance by O. Schofield on estimates of effort		2.0	6	12.0	Concurrance by O. Schofield on estimates of effort	

Passive PI Instrument,		OSMOI	Osmotic Sampler	1 year	10 years	2	Seep fluid dissolved gas chemistry ??	Physical Water Sample							0.77	2	1.5	Annual Collection Post-analysis; 1 full week of QA/QC work/yr instrument (G. Proskurowski)		0.77	2	1.54	Annual Collection Post-analysis; 1 full week of QA/QC work (G. Proskurowski)		0.77	2	1.54	Annual Collection Post-analysis; 1 full week of QA/QC work (G. Proskurowski)	
up to 350 meters supported according to data sheet. Typical RS-232 is limited to 10 meters	Two Alternate Possiblities	PARAD	Photosynthetically Active Radiation Sensor, Biospherical Instruments QSP-2100	Annual	5 years	2	PAR	PAR												1.0	2	2.0	Concurrance by O. Schofield on estimates of effort		1.0	2	2.0	Concurrance by O. Schofield on estimates of effort	
		PCO2W	Partial CO2 in Water, Sunburst SAMI-15000	Annual	5 years	2	pCO2 Seawater	pCO2												4.0	2	8.0	Also monitor pH		4.0	2	8.0	Also monitor pH	C. Sabine of NOAA/PMEL agrees with 4.0 hrs/ week per instrument for base QC analyses.
	Four Alternate Possibilities	PHSEN	AMT Analysenmeßtechnik GmbH (German Company), AMT-6000m version pH sensor			4	pH	pH												4.0	4	16.0	Also monitor pCO2		4.0	4	16.0	Also monitor pCO2	C. Sabine of NOAA/PMEL agrees with 4.0 hrs/ week per instrument for base QC analyses.
		PPSDN	McClane Phytoplankton Particulate DNA Sampler	Annual	10 years	1	Microbial DNA Analysis	Physical Particulates												0.77	1	0.77	Annual Collection Post-analysis; 1 full week of QA/QC work/yr instrument (G. Proskurowski)		0.77	1	0.77	Annual Collection Post-analysis; 1 full week of QA/QC work/yr instrument (G. Proskurowski)	
		PREST	ParoScientific 1787-003-0 model 8BT4000-1-254	5 years	10 years	3	Pressure Temperature	Pressure Temperature		3.0	1	3.0	Ck drift worse initial; annual recal		3.0	3	9.0	Ck drift worse initial; annual recal		3.0	3	9.0	Ck drift worse initial; annual recal; detide ck		3.0	3	9.0	Ck drift worse initial; annual recal; detide ck	
	Two Alternate Possiblities	RASFL	McClane Water Transfer Sampler: major/trace element chemistry, temp, H2S, pH	1 year	10 years	1	Diffuse Flow and Seep Fluids	Physical Water Sample							0.77	1	0.77	Ck Sampling Post-collection analysis		0.77	1	0.77	Ck Sampling; post-collection analysis		0.77	1	0.77	Ck Sampling; post-collection analysis	
		SPKIR	Spectral Irradiation, OCR-507	Annual	5 years	2	Downwelling Spectral Irradiance	Downwelling Spectral Irradiance												3.0	2	6.0	Concurrance by O. Schofield on estimates of effort		3.0	2	6.0	Concurrance by O. Schofield on estimates of effort	
		THSPH	High Temp H2S pH; Black smoker fluid temperature, hydrogen, hydrogen sulphide, chlorinity;	Annual	1 year	1	Vent Fluid pH, Temp H2 chem	Temp H2 H2S pH							4.0	1	4.0	Based on estimate made by instrument PI (M. Lilley)		4.0	1	4.0	Based on estimate made by instrument PI (M. Lilley)		4.0	1	4.0	Based on estimate made by instrument PI (M. Lilley)	
PI instrument: Deb Kelly		TMPSF	Thermistor Array, measures diffuse heat flux of seafloor	5 years	5 years	1	Temp	Temp							0.5	1	0.5			0.5	1	0.5			0.5	1	0.5		
	Two Alternate Possiblities?	TRHPH	Black smoker fluid temperature, hydrogen, and chlorintiy(by resistivity)	Annual	1 year	1	Vent Fluid chloride conc	Fluid Resistivity Temp							3.0	1	3.0			3.0	1	3.0			3.0	1	3.0		
Custom Device at Behest of Bruce Howe/APL and Anne Gargett/Skidaway		VADCP	RDI 5-Beam ADCP 300kHz	3 years	10 years	2	Turbulent Water Velocity Profiles	Velocity Profiles Acoustic Back Orientation												6.3	2	12.5	1.25 x ADCP LOE		6.3	2	12.5	1.25 x ADCP LOE	2011-03-21 OEK consulted Paul Freitag (TAO Data Manager - lots of experience w/ ADCP QA/QC) - Based on the total number of ADCPs and VADCPs, thought we would need approx. one full-time person. Compare it with our 37.5 hrs/ week estimate
	Two Alternate Possiblities	VEL3D	Falmouth Scientific Inc. 3D-ACM+ Compact, Vector Averaged Current Speed and Direction Meter			8	3-D point single point velocity, fast enough to measure turbulence properties like Reynolds stress, fluctuating velocity in u,v,w (u',v',w') or platform motion on moving profilers	Velocity (3D) Acoustic bs Orient							3.0	4	12.0	4 paths x 0.750 hr/wk		3.0	8	24.0	4 paths x 0.75 hr/wk		3.0	8	24.0	4 paths x 0.75hr/wk	
		ZPLKS	Zooplankton sonar, EK-60	5 years	10 years	2	Acoustic backscatter	AC BS												2.5	2	5.0			2.5	2	5.0		4/21/11 Based on Discussions with John K. Horne (U of W School of Fisheries) who deployed on MARS, 5 hours a week for 2 instruments would allow manual QC of flagged data and production of reasonable product for community.
												10	**Manual QC hrs/week (Res Scientist II)**				**101.81**	**Manual QC hrs/week (Res Scientist II)**				**240.58**	**Manual QC hrs/week (Res Scientist II)**				**240.58**	**Manual QC hrs/week (Res Scientist II)**	
												0.3	**TOTAL FTE Research Scientist II**				2.9	**TOTAL FTE Research Scientist II+**				7.0	**TOTAL FTE Research Scientist II+**				7.0	**TOTAL FTE Research Scientist II+**	

Regional Scale Nodes Operations and Maintenance Sustaining Engineering Basis of Estimate

Version 1-02



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1-00	5/4/11	Initial Version	S. Denny
1-01	5/5/11	updated	S. Denny
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1. Sustaining Engineering

OOI O&M Sustaining Engineering involves all engineering work and materials related to the maintenance, repair and refurbishment of secondary infrastructure and refurbishment and calibration of core instruments on the RSN. Included is support for the operations center and management. Additionally, engineering support may be provided for new instrumentation brought onto the system, as described in the strawman NSF proposal process.

Engineering activities transition from construction to O&M commences in 2011 and is at steady state by 2015. Figure 1. Displays the ramp-up over this time interval. It is extremely valuable to retain the "corporate knowledge" of construction over into operation and selection of engineers has been made with this in mind.

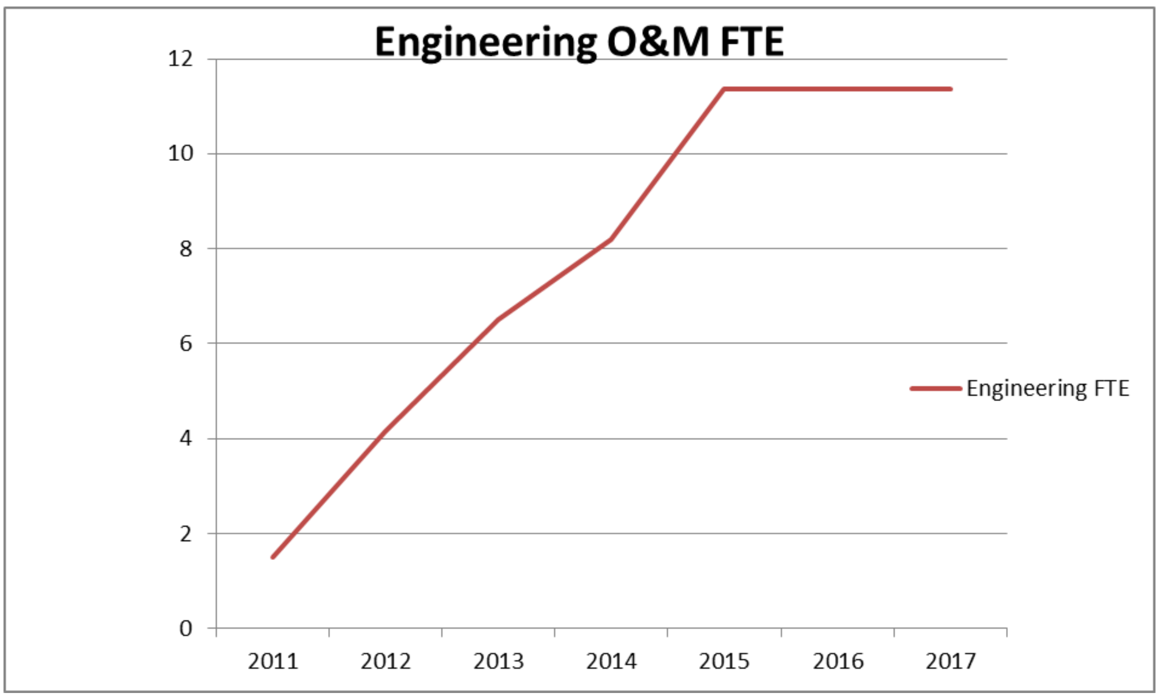


Figure 1. Engineering Ramp-up in FTE by Calendar Year

1.1. Task Descriptions (CY2, 2011)

Tasking for CY2 for engineering begins the O&M ramp-up by defining the necessary processes and procedures to affect Sustaining Engineering. The initial efforts are to establish the scope and quality of engineering activities and estimate long-term needs in both personnel and materials.

Driving activities during year include completion of designs for the secondary infrastructure and acquisition of core instrumentation. Primary cabling will be installed by end of summer. O&M

activities begin by determining calibration and refurbishment needs of the chosen sensors, establishment of the refurbishment cycles for the infrastructure and establishment of the logistics to track and store all materials.

WBS Elements:

WBS	WBS Title
2.4.1.2.2	Sustaining Engineering - 2011
2.4.1.2.2.0	SPA - OM Year 2 (2011) Sustaining Engineering
2.4.1.2.2.20	MATL - Sustaining Engineering - 2011
2.4.1.2.2.21	TRVL - Sustaining Engineering - 2011
2.4.1.2.2.22	SUBS - Sustaining Engineering - 2011
2.4.1.2.2.23	EQUP - Sustaining Engineering - 2011
2.4.1.2.2.24	Engineering Oversight / Support - 2011
2.4.1.2.2.25	APL Technical Support Center - 2011

1.1.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world's oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Based on the overall APL experience we have a high level of confidence in the identified resource requirements.

1.1.2. Resource Estimates

Personnel Resources	FTE
Total: (Sustaining Engineering)	**1.5**
Sr. Systems Engineer (SE)	0.12
Sr. Ocean Engineer (OE)	0.12
Field Engineer (FE)	1.25
Sr. Electronics Engineer (EE)	0.12
Calibration costs {Cal Costs sheet}	$0
Infrastructure Tooling	$0
Total	$0

TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	
TOTAL TRAVEL (Days)	8
Travel Est @$1000/trip/person	$8,000
Non-Labor Costs/year	**$8,000**

1.2. Task Descriptions (CY3, 2012)

Tasking for CY3 for engineering continues the early O&M ramp-up by writing the necessary processes and procedures to affect Sustaining Engineering. The initial efforts are to establish the scope and quality of engineering activities and estimate long-term needs in both personnel and materials.

Driving activities during year include completion of designs and initial build and test of the secondary infrastructure and testing of core instrumentation. The Primary Infrastructure will be complete by end of summer. O&M activities begin by determining calibration and refurbishment needs of the chosen sensors, establishment of the refurbishment cycles for the infrastructure. Logistics begins to track and store all infrastructure materials and core instruments.

WBS Elements:

WBS	WBS Title
2.4.1.3.2	Sustaining Engineering - 2012
2.4.1.3.2.0	SPA - OM Year 2 (2012) Sustaining Engineering
2.4.1.3.2.20	MATL - Sustaining Engineering - 2012
2.4.1.3.2.21	TRVL - Sustaining Engineering - 2012
2.4.1.3.2.22	SUBS - Sustaining Engineering - 2012
2.4.1.3.2.23	EQUP - Sustaining Engineering - 2012
2.4.1.3.2.24	Engineering Oversight / Support - 2012
2.4.1.3.2.25	APL Technical Support Center - 2012

1.2.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world's oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

1.2.2. Resource Estimates

RESOURCES	FTE
Total: (Sustaining Engineering)	**4.16**
Lead Field Engineer	0.5
Field Engineer	1.0
Sr. Ocean Engineer	0.33
Electronics Engineer 4 (EE)	0.5
Sr. Systems Engineer (SE)	0.5
Field Engineer (FE), Document Mgr.	0.5
Mechanical Engineer (ME)	0.33
Sr. Electrical Engineer	0.5
Calibration costs {Cal Costs sheet}	$0
Infrastructure Tooling	$45,000
Material Subtotals:	$45,000
TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	
TOTAL TRAVEL (Days)	8
Travel Est @$1000/trip/person	$8,000

1.3. Task Descriptions (CY4, 2013)

Tasking for CY4 for engineering continues the handoff from construction. Efforts are to begin implementing the processes and procedures and activate the quality engineering activities and re-evaluate long-term needs in both personnel and materials.

Driving activities during year include installation and test of the secondary infrastructure and core instrumentation in seafloor sites at both Hydrate and Axial with a projected 40 days at sea. O&M activities begin in earnest with support for the operations center, preparation of calibration and refurbishment needs of the chosen sensors, preparation for the refurbishment cycles for the infrastructure. Logistics tracks and stores all infrastructure materials and core instruments both on shore and in the water.

Acquisition of spares is based on needs for at least 1 spare for each deployed instrument and acquiring the turn instruments in the year before their deployment to assure delivery and checkout with the infrastructure.

WBS Elements:

WBS	WBS Title
2.4.1.4.2	Sustaining Engineering - 2013
2.4.1.4.2.0	SPA - OM Year 2 (2013) Sustaining Engineering
2.4.1.4.2.20	MATL - Sustaining Engineering - 2013
2.4.1.4.2.21	TRVL - Sustaining Engineering - 2013
2.4.1.4.2.22	SUBS - Sustaining Engineering - 2013
2.4.1.4.2.23	EQUP - Sustaining Engineering - 2013
2.4.1.4.2.24	Engineering Oversight / Support - 2013
2.4.1.4.2.25	APL Technical Support Center - 2013

1.3.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world's oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Based on the overall APL experience we have a high level of confidence in the identified resource requirements.

Construction engineers begin to migrate to the O&M side and initially will monitor and document the operation of the system and begin the trouble-shooting diagrams.

1.3.2. Resource Estimates

RESOURCES	FTE
Total: (Sustaining Engineering)	**6.5**
Lead Field Engineer	0.5
Field Engineer	2.0
Sr. Ocean Engineer	1.0
Electronics Engineer 4 (EE)	0.5
Sr. Systems Engineer (SE)	0.5
Field Engineer (FE), Document Mgr.	0.5
Mechanical Engineer 4 (ME)	0.5
Sr. Electrical Engineer	0.5
Software Engineer 4	0.5
Calibration costs {Cal Costs sheet}	$325
Infrastructure Tooling	
Material Subtotals:	$325
TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1?	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	
TOTAL TRAVEL (Days)	8
Travel Est @$1000/trip/person	$8,000

1.4. Task Descriptions (CY5, 2014)

Tasking for CY5 for engineering coninues the handoff from construction. Efforts are to begin implementing the processes and procedures and activate the quality engineering activities and re-evaluate long-term needs in both personnel and materials.

Driving activities during year include installation and test of the hybrid moorings at both Hydrate and Axial and the CG 600m site on Endurance with a projected 79 days at sea. O&M activities continue support for the operations center, start calibration and refurbishment needs of the chosen sensors, begin the refurbishment cycles for the infrastructure. Logistics tracks and stores all infrastructure materials and core instruments both on shore and in the water.

Acquisition of spares is based on needs for at least 1 spare for each deployed instrument and acquiring the turn instruments in the year before their deployment to assure delivery and checkout with the infrastructure.

It is estimated that community workshops will begin that will require attendance of engineering personnel to describe processes and assistance available to put new instrumentation onto the system.

WBS Elements:

WBS	WBS Title
2.4.1.5.2	Sustaining Engineering - 2014
2.4.1.5.2.0	SPA - OM Year 2 (2014) Sustaining Engineering
2.4.1.5.2.20	MATL - Sustaining Engineering - 2014
2.4.1.5.2.21	TRVL - Sustaining Engineering - 2014
2.4.1.5.2.22	SUBS - Sustaining Engineering - 2014
2.4.1.5.2.23	EQUP - Sustaining Engineering - 2014
2.4.1.5.2.24	Engineering Oversight / Support - 2014
2.4.1.5.2.25	APL Technical Support Center - 2014

1.4.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world's oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Based on the overall APL experience we have a high level of confidence in the identified resource requirements.

Construction engineers migrate to the O&M side and will monitor and document the operation of the system and establish the trouble-shooting diagrams. This will keep the "corporate knowledge" in-house, a flaw noted with Neptune Canada's approach.

1.4.2. Resource Estimates

RESOURCES	FTE
Total: (Sustaining Engineering)	**8.19**
Lead Field Engineer	0.67
Field Engineer	2.0
Sr. Ocean Engineer	0.67
Electronics Engineer 4 (EE)	1.5
Sr. Systems Engineer (SE)	0.67
Field Engineer (FE), Document Mgr.	0.67
Mechanical Engineer 4 (ME)	0.67
Sr. Electrical Engineer	0.67
Software Engineer 4	0.67
Calibration costs {Cal Costs sheet}	$109,000
Infrastructure Tooling	
Material Subtotals:	$109,000
TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1?	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	2
TOTAL TRAVEL (Days)	10
Travel Est @$1000/trip/person	$10,000

1.5. Task Descriptions (CY6, 2015)

Tasking for CY6 for engineering completes the handoff from construction. Efforts are to fully implement the processes and procedures developed in the preceding years and activate the quality engineering activities and establish long-term needs in both personnel and materials.

Driving activities during year include maintenance cruises (2, 20-day cruises) at both Hydrate and Axial. O&M activities continue support for the operations center, calibration and refurbishment needs of the chosen sensors and the refurbishment cycles for the infrastructure. Logistics continues the “steady state” tracking and storage of all infrastructure materials and core instruments both on shore and in the water.

Acquisition of spares is based on needs for at least 1 spare for each deployed instrument and acquiring the turn instruments in the year before their deployment to assure delivery and checkout with the infrastructure.

It is estimated that community workshops will begin that will require attendance of engineering personnel to describe processes and assistance available to put new instrumentation onto the system.

WBS Elements:

WBS	WBS Title
2.4.1.6.2	Sustaining Engineering - 2015
2.4.1.6.2.0	SPA - OM Year 2 (2015) Sustaining Engineering
2.4.1.6.2.20	MATL - Sustaining Engineering - 2015
2.4.1.6.2.21	TRVL - Sustaining Engineering - 2015
2.4.1.6.2.22	SUBS - Sustaining Engineering - 2015
2.4.1.6.2.23	EQUP - Sustaining Engineering - 2015
2.4.1.6.2.24	Engineering Oversight / Support - 2015
2.4.1.6.2.25	APL Technical Support Center - 2015

1.5.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world’s oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Based on the overall APL experience we have a high level of confidence in the identified resource requirements.

Construction engineers have migrated to the O&M side and will monitor and document the operation of the system and establish the trouble-shooting diagrams. This will keep the "corporate knowledge" in-house, a flaw noted with Neptune Canada's approach. This is the "steady state" condition of resources.

1.5.2. Resource Estimates

RESOURCES	FTE
Total: (Sustaining Engineering)	**11.35**
Lead Field Engineer	1.0
Field Engineer	2.0
Sr. Ocean Engineer	1.5
Electronics Engineer 4 (EE)	2.0
Sr. Systems Engineer (SE)	1.0
Field Engineer (FE), Document Mgr.	1.0
Mechanical Engineer 4 (ME)	0.85
Sr. Electrical Engineer	1.0
Software Engineer 4	1.0
Calibration costs {Cal Costs sheet}	$121,065
Infrastructure Tooling	
Material Subtotals:	$121,065
TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1?	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	2
TOTAL TRAVEL (Days)	10
Travel Est @$1000/trip/person	$10,000

1.6. Task Descriptions (CY7, 2016)

Tasking for CY7 for engineering completes the handoff from construction. Efforts are to fully implement the processes and procedures developed in the preceding years and activate the quality engineering activities and establish long-term needs in both personnel and materials.

Driving activities during year include maintenance cruises (2, 20-day cruises) at both Hydrate and Axial. O&M activities continue support for the operations center, calibration and refurbishment needs of the chosen sensors and the refurbishment cycles for the infrastructure. Logistics continues the "steady state" tracking and storage of all infrastructure materials and core instruments both on shore and in the water.

Acquisition of spares is based on needs for at least 1 spare for each deployed instrument and acquiring the turn instruments in the year before their deployment to assure delivery and checkout with the infrastructure.

It is estimated that community workshops will begin that will require attendance of engineering personnel to describe processes and assistance available to put new instrumentation onto the system.

WBS Elements:

WBS	WBS Title
2.4.1.7.2	Sustaining Engineering - 2016
2.1.4.7.2.0	SPA - OM Year 2 (2016) Sustaining Engineering
2.1.4.7.2.20	MATL - Sustaining Engineering - 2016
2.1.4.7.2.21	TRVL - Sustaining Engineering - 2016
2.1.4.7.2.22	SUBS - Sustaining Engineering - 2016
2.1.4.7.2.23	EQUP - Sustaining Engineering - 2016
2.1.4.7.2.24	Engineering Oversight / Support - 2016
2.1.4.7.2.25	APL Technical Support Center - 2016

1.6.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world's oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Construction engineers have migrated to the O&M side and will monitor and document the operation of the system and establish the trouble-shooting diagrams. This will keep the "corporate knowledge" in-house, a flaw noted with Neptune Canada's approach. This is the "steady state" condition of resources.

1.6.2. Resource Estimates

RESOURCES	FTE
Total: (Sustaining Engineering)	**11.35**
Lead Field Engineer	1.0
Field Engineer	2.0
Sr. Ocean Engineer	1.5
Electronics Engineer 4 (EE)	2.0
Sr. Systems Engineer (SE)	1.0
Field Engineer (FE), Document Mgr.	1.0
Mechanical Engineer 4 (ME)	0.85
Sr. Electrical Engineer	1.0
Software Engineer 4	1.0

Calibration costs {Cal Costs sheet}	$121,065
Infrastructure Tooling	
Material Subtotals:	$121,065

TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1?	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	2
TOTAL TRAVEL (Days)	10
Travel Est @$1000/trip/person	$10,000

1.7. Task Descriptions (CY8, 2017)

Tasking for CY8 for engineering completes the handoff from construction. Efforts are to fully implement the processes and procedures developed in the preceding years and activate the quality engineering activities and establish long-term needs in both personnel and materials.

Driving activities during year include maintenance cruises (2, 20-day cruises) at both Hydrate and Axial. O&M activities continue support for the operations center, calibration and refurbishment needs of the chosen sensors and the refurbishment cycles for the infrastructure.

Logistics continues the “steady state” tracking and storage of all infrastructure materials and core instruments both on shore and in the water.

Acquisition of spares is based on needs for at least 1 spare for each deployed instrument and acquiring the turn instruments in the year before their deployment to assure delivery and checkout with the infrastructure.

It is estimated that community workshops will begin that will require attendance of engineering personnel to describe processes and assistance available to put new instrumentation onto the system.

WBS Elements:

WBS	WBS Title
2.4.1.8.2	Sustaining Engineering - 2017
2.1.4.8.2.0	SPA - OM Year 2 (2017) Sustaining Engineering
2.1.4.8.2.20	MATL - Sustaining Engineering - 2017
2.1.4.8.2.21	TRVL - Sustaining Engineering - 2017
2.1.4.8.2.22	SUBS - Sustaining Engineering - 2017
2.1.4.8.2.23	EQUP - Sustaining Engineering - 2017
2.1.4.8.2.24	Engineering Oversight / Support - 2017
2.1.4.8.2.25	APL Technical Support Center - 2017

1.7.1. Basis of Estimate

Estimates are based on the experience of an Applied Physics Laboratory (APL) Senior Ocean Engineer with or 35 years of experience in performing similar activities on dozens of R&D Projects. APL has been providing technology for the US Navy, NSF, DARPA, NOAA, JPL, US Army, NIH and NASA for nearly 70 years Scientists and engineers have conducted interdisciplinary research and developed technologies to operate in every corner of the world’s oceans. The RSN team has also brought in several engineers (both intermediate for the long run and senior to mentor) from industry to further augment this expertise. APL has specialized facilities for acoustics, remote sensing, image processing and electronic systems and is one of 5 unique laboratories in the country. The positions identified below can be found in RSN_O&M_Position_Description_Abstract_2011-04-21_ver_1-03.doc posted in Alfresco.

Based on the overall APL experience we have a high level of confidence in the identified resource requirements.

Construction engineers have migrated to the O&M side and will monitor and document the operation of the system and establish the trouble-shooting diagrams. This will keep the “corporate knowledge” in-house, a flaw noted with Neptune Canada’s approach. This is the “steady state” condition of resources.

1.7.2. Resource Estimates

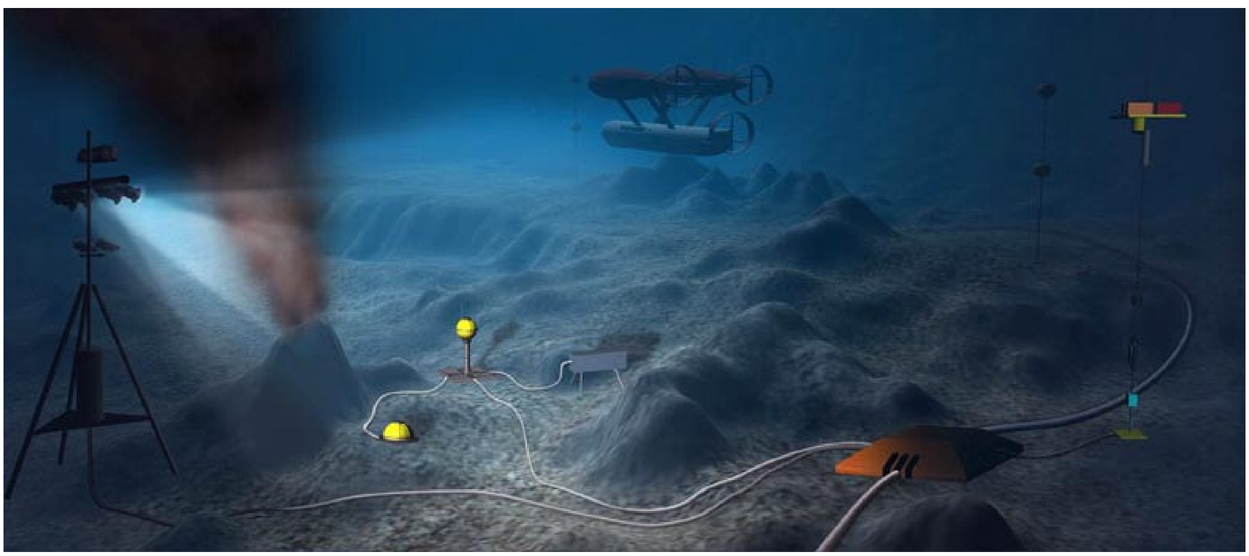
RESOURCES	FTE
Total: (Sustaining Engineering)	**11.35**
Lead Field Engineer	1.0
Field Engineer	2.0
Sr. Ocean Engineer	1.5
Electronics Engineer 4 (EE)	2.0
Sr. Systems Engineer (SE)	1.0
Field Engineer (FE), Document Mgr.	1.0
Mechanical Engineer 4 (ME)	0.85
Sr. Electrical Engineer	1.0
Software Engineer 4	1.0

Calibration costs {Cal Costs sheet}	$121,065
Infrastructure Tooling	
Material Subtotals:	$121,065

TRAVEL	
O&M Meetings	
O&M Quaterly Mtgs - WG co-lead trips	4
Annual Reviews/Prep - Lead, +1?	4
Community Workshops	
Ccommunity Input workshops (2 WS/year, 2 days ea)	2
TOTAL TRAVEL (Days)	10
Travel Est @$1000/trip/person	$10,000

Regional Scale Nodes Operations and Maintenance Transmission Facilities Basis of Estimate

Version 1-00



Prepared by
University of Washington for the
Ocean Observatories Initiative

May 5, 2011

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Document Control Sheet

Version	Release Date	Description	By
1-00		Initial Version	B. Ittig

Table of Contents

1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). This document contains the Basis of Estimate for the Transmission Facilities required during the Operation and Maintenance phase of the program including the Shore Station in Pacific City, OR; the Point-of-Presence (POP) in Portland, OR; and logistics/maintenance facilities in Oregon and Washington states.

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name	WBS Definition
2.4.1.2.4	C	Transmission Facilities - 2011	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to support the ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 2 (2011). The leased space comprises facilities for the Pacific City Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.2.4.20	W	MATL - Transmission Facilities - 2011	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.4.21	W	TRVL - Transmission Facilities - 2011	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.4.22	W	SUBS - Transmission Facilities - 2011	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011). This work package captures the lease costs associated with up to six rack spaces in the Pittock Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Station; lease costs associated with maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.2.4.23	W	EQUP - Transmission Facilities - 2011	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar

WBS #	Element Type	Name	WBS Definition
			Year 2 (2011).
2.4.1.2.4.24	W	Portland Oregon CyberPoP - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance of the leased space in the Pittock Building at Portland, OR for O&M Calendar Year 2 (2011). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub for the metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunications providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.2.4.25	W	Pacific City Oregon Shore Facility - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance of the 4,000 sq ft of space at the Pacific City, OR Shore Station; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 2 (2011). The facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppression, and environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.2.4.26	W	Logistics/Maintenance Facility, Oregon - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance of a logistics and maintenance facility on the Oregon coast for O&M Calendar Year 2 (2011). The facilities will be established to support the storage and maintenance of secondary infrastructure including instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respond to issues at either the cable station or CyberPoP.
2.4.1.2.4.27	W	Logistics/Maintenance Facility - Washington - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance with of a logistics and maintenance facility in Washington for O&M Calendar Year 2 (2011). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.

Note: Above Control Accounts/Work Packages are for Calendar Year 2. Similar Control Accounts/Work Packages created for each Calendar Year – associated WBS number is identical to the above structure except for the fourth digit, which is modified to represent the Calendar Year.

2.2. Task Description

The tasks involved in calendar years 2011 through 2014 includes procuring the facilities to locate the required terrestrial transmission equipment; and procuring facilities to support the storage and maintenance of secondary infrastructure including extension cables and instruments. The required identified facilities include:

- Shore Station in Pacific City, OR;
- Point-of-Presence (POP) in Portland, OR;
- logistics/maintenance facility in Oregon; and
- logistics/maintenance facility in Washington.

2.3. Estimation Technique

Shore Station – Pacific City, Oregon
Estimation Technique: (Fully Executed Lease attached as Enclosure (1))

- Lease costs: Actual costs known
- Utility costs: Initial costs known based on monthly average; however the transmission equipment is not scheduled to be installed until Summer 2011. Steady state utility costs are estimated based on Implementing Organizations' understanding of the project scope as it relates to commercial undersea cable projects.

The Pacific City Shore Station is a special-purpose built facility for telecommunications cables located on a 5-acre lot at 33395 Cape Kiwanda Drive in Pacific City, OR. The facility was recently purchased by Tillamook Lightwave IGA; and a Colocation and Lease Agreement for 4,000 ft^2 of space to operate and maintain the OOI terminal station equipment was completed in June 2010. The services under this agreement provide the physical structure and required support infrastructure for the RSN support and termination equipment that will allow the collection of scientific data. The agreement is for an initial term of fifteen (15) years, with an option to extend the lease for three (3) additional terms of five (5) years each. The negotiated rate for this facility is $20,000.

Point-of-Presence (POP) in Portland, OR
Estimation Technique: (Fully Executed Lease attached as Enclosure (2))

- Lease / Utility costs: Lease Agreement complete; utilities included in monthly lease cost.

A Right of Entry and License Agreement has been negotiated for the lease of secure floor area, colocation space, in The Pittock Internet Exchange in Portland, OR. This agreement permits the installation, operation, maintenance, repair, and replacement of telecommunications cable and equipment in the colocation space. The agreement is for the lease of approximately 225 ft^2 of secure floor area for an initial term of five (5) years, with an option to extend the lease for five (5) additional terms of five (5) years each. The negotiated rate for this facility is $5,400; plus $100 per fiber optic circuit cross connect. The UW anticipates two fiber optic cross connects will be required. The total monthly fee for colocation space and required fiber optic cross connects at the Pittock Internet Exchange is $5,600. This monthly cost is for a fully protected path.

Logistics/Maintenance Facility - Oregon, OR
Estimation Technique: The costs for the Logistics/Maintenance Facility in Oregon, OR are estimated based on knowledge of local commercial real estate rates. Notional Layout enclosed as Enclosure 3.

Logistics/Maintenance Facility – Seattle, WA
The recurring lease and utility costs for a Logistics/Maintenance Facility in Seattle, WA are being proposed to be provided by the University of Washington (i.e. no lease/utility cost to be provided by the program). Refurbishment and security costs are estimated based on knowledge of the property.

Labor / Travel:
Engineering Estimates: Estimates based on known resources rates and Implementing Organizations' understanding of the project scope as it relates to engineering support requirements and commercial undersea cable construction projects. Estimates are based on experience of estimators with over 50 years of experience in performing similar activities on submarine cable networks.

3. Budgeted Unit Quantities

Unit	2011	2012	2013	2014	2015
Travel	6	12	12	12	12
Subcontracts					
• Shore Station Lease / Utilities	8 months	12 months	12 months	12 months	12 months
• Portland POP Lease	8 months	12 months	12 months	12 months	12 months
• Maintenance Facility – WA	8 months	12 months	12 months	12 months	12 months
• Maintenance Facility – OR	-	6 months	12 months	12 months	12 months
Equipment		1		1	
Labor	3200 hours	5400 hours	5400 hours	5400 hours	5400 hours

Unit quantities are based on full year facility occupation. Each of the unit cost for the items in this BOE are captured below.

4. Unit Cost Estimates

4.1. Task Descriptions (CY2, 2011)

Travel – Field Engineers will be required to travel to the transmission facilities for facility management and maintenance, and equipment inspection and maintenance. Required travel is estimated at one (1) trip / month (rotating facilities) = 6 Total Domestic Trips.

Subcontracts – Transmission facility lease and utility payments are monthly.

Labor – Responsible for the maintenance and operation of the shore station, transmission equipment, outside plant, of the 800km network of fiber optic cable; and the POP at the Pittock

Building in Portland, OR. Field engineers are responsible for day to day management of the Oregon field operations and maintenance; and shore station maintenance and security.

Primary cabling will be installed by end of summer in CY2 and O&M activities will also include monitoring of the submarine cable equipment.

4.2. Resource Estimates (CY2, 2011)

Travel

Total: (Transmission Facilities)	**6**
Facility Inspection and Maintenance	6

Subcontracts

Total: (Transmission Facilities)	
Shore Station – Pacific City, OR ($20,000 / month for 8 months)	$160,000
Shore Station Utilities ($1,500 / month for 8 months)	$20,000
Pittock Building - Portland, OR ($5,600 / month for 8 months)	$44,800
(includes 2 fiber optic circuit cross connect at $100 per)	
Maintenance Facility – WA ($1,000 / month for security)	$8,000

Equipment

Total: (Transmission Facilities)	
Shore Station and Pittock Building Spare Equipment	$320,000

Labor

Total: (Transmission Facilities)	
Field Operations Manager	2 FTE

4.3. Task Descriptions (CY3, 2012)

Travel – Field Engineers will be required to travel to the transmission facilities for facility management and maintenance, and equipment inspection and maintenance. Required travel is estimated at one (1) trip / month (rotating facilities) = 12 Total Domestic Trips.

Subcontracts – Transmission facility lease and utility payments are monthly.

Labor – Responsible for the maintenance and operation of the shore station, transmission equipment, outside plant, of the 800km network of fiber optic cable; and the POP at the Pittock Building in Portland, OR. Field engineers are responsible for day to day management of the Oregon field operations and maintenance; and shore station maintenance and security. Primary cabling installed by Summer in CY2 and O&M activities will also include monitoring of the submarine cable equipment. The Maintenance Facility in Oregon will be established and field engineers will be required to operate and maintain this facility.

4.4. Resource Estimates (CY3, 2012)

Travel

Total: (Transmission Facilities)	**12**
Facility Inspection and Maintenance	12

Subcontracts

Total: (Transmission Facilities)	
Shore Station – Pacific City, OR ($20,000 / month for 12 months)	$240,000
Shore Station Utilities ($7,500 / month for 12 months)	$90,000
Pittock Building - Portland, OR ($5,600 / month for 12 months)	$67,200
(includes 2 fiber optic circuit cross connect at $100 per)	
Maintenance Facility – OR (10kft^2 at $0.55/ft^2 / month for 12 months)	$116,000
(includes space refurbishment costs)	
Maintenance Facility – WA ($1,500 / month -security & maintenance)	$20,000

Equipment

Total: (Transmission Facilities)	
Shore Station and Pittock Building Spare Equipment	$0

Labor

Total: (Transmission Facilities)	
Field Operations Manager	2 FTE
APL Field Engineer	1 FTE

4.5. Task Descriptions (CY4, 2013)

Travel – Field Engineers will be required to travel to the transmission facilities for facility management and maintenance, and equipment inspection and maintenance. Required travel is estimated at one (1) trip / month (rotating facilities) = 12 Total Domestic Trips.

Subcontracts – Transmission facility lease and utility payments are monthly.

Labor – Responsible for the maintenance and operation of the shore station, transmission equipment, outside plant, of the 800km network of fiber optic cable; and the POP at the Pittock Building in Portland, OR. Field engineers are responsible for day to day management of the Oregon field operations and maintenance; shore station maintenance and security; and monitoring of the submarine cable equipment. The Maintenance Facilities in Oregon and Washington will have been established and field engineers will be required to operate and maintain the facilities.

4.6. Resource Estimates (CY4, 2013)

Travel

Total: (Transmission Facilities)	**12**
Facility Inspection and Maintenance	12

Subcontracts

Total: (Transmission Facilities)	
Shore Station – Pacific City, OR ($20,000 / month for 12 months)	$240,000
Shore Station Utilities ($7,500 / month for 12 months)	$90,000
Pittock Building - Portland, OR ($5,600 / month for 12 months)	$67,200
(includes 2 fiber optic circuit cross connect at $100 per)	
Maintenance Facility – OR (10kft^2 at $0.55/ft^2 / month for 12 months)	$66,000
(includes space refurbishment costs)	
Maintenance Facility – WA ($1,500 / month –security & maintenance)	$20,000

Equipment

Total: (Transmission Facilities)	
Shore Station and Pittock Building Spare Equipment	$100,000

Labor

Total: (Transmission Facilities)	
Field Operations Manager	2 FTE
APL Field Engineer	1 FTE

4.7. Task Descriptions (CY5, 2014)

Travel – Field Engineers will be required to travel to the transmission facilities for facility management and maintenance, and equipment inspection and maintenance. Required travel is estimated at one (1) trip / month (rotating facilities) = 12 Total Domestic Trips.

Subcontracts – Transmission facility lease and utility payments are monthly.

Labor – Responsible for the maintenance and operation of the shore station, transmission equipment, outside plant, of the 800km network of fiber optic cable; and the POP at the Pittock Building in Portland, OR. Field engineers are responsible for day to day management of the Oregon field operations and maintenance; shore station maintenance and security; and monitoring of the submarine cable equipment. The Maintenance Facilities in Oregon and Washington will have been established and field engineers will be required to operate and maintain the facilities.

4.8. Resource Estimates (CY5, 2014)

Travel

Total: (Transmission Facilities)	**12**
Facility Inspection and Maintenance	12

Subcontracts

Total: (Transmission Facilities)	
Shore Station – Pacific City, OR ($20,000 / month for 12 months)	$240,000
Shore Station Utilities ($7,500 / month for 12 months)	$90,000
Pittock Building - Portland, OR ($5,600 / month for 12 months)	$67,200
(includes 2 fiber optic circuit cross connect at $100 per)	
Maintenance Facility – OR (10kft^2 at $0.55/ft^2 / month for 12 months)	$116,000
(includes space refurbishment costs)	
Maintenance Facility – WA ($1,500 / month -security & maintenance)	$20,000

Labor

Total: (Transmission Facilities)	
Field Operations Manager	2 FTE
APL Field Engineer	1 FTE

5. Steady State

5.1. Task Descriptions (Steady State)

Travel – Field Engineers will be required to travel to the transmission facilities for facility management and maintenance, and equipment inspection and maintenance. Required travel is estimated at one (1) trip / month (rotating facilities) = 12 Total Domestic Trips.

Subcontracts – Transmission facility lease and utility payments are monthly.

Labor – Responsible for the maintenance and operation of the shore station, transmission equipment, outside plant, of the 800km network of fiber optic cable; and the POP at the Pittock Building in Portland, OR. Field engineers are responsible for day to day management of the Oregon field operations and maintenance; shore station maintenance and security; and monitoring of the submarine cable equipment. The Maintenance Facilities in Oregon and Washington will have been established and field engineers will be required to operate and maintain the facilities.

5.2. Resource Estimates (Steady State)

Travel

Total: (Transmission Facilities)	**12**
Facility Inspection and Maintenance	12

Subcontracts

Total: (Transmission Facilities)	
Shore Station – Pacific City, OR ($20,000 / month for 12 months)	$240,000
Shore Station Utilities ($7,500 / month for 12 months)	$90,000
Pittock Building - Portland, OR ($5,600 / month for 12 months) (includes 2 fiber optic circuit cross connect at $100 per)	$67,200
Maintenance Facility – OR (10kft^2 at $0.55/ft^2 / month for 12 months) (includes space refurbishment costs)	$66,000
Maintenance Facility – WA ($1,500 / month –security & maintenance)	$20,000

Equipment

Total: (Transmission Facilities)	
Shore Station and Pittock Building Spare Equipment	$100,000

Labor

Total: (Transmission Facilities)	
Field Operations Manager	2 FTE
APL Field Engineer	1 FTE

COLOCATION AND LEASE AGREEMENT

This Colocation and Lease Agreement ("**Lease**") is made and entered into as of this 28th day of May, 2010 ("**Effective Date**"), by and between Tillamook Lightwave IGA, an intergovernmental agency consisting of Tillamook County, Tillamook People's Utility District and the Port of Tillamook Bay ("**Lessor**"), and the Board of Regents of the University of Washington, a state university and institution of higher learning in the State of Washington ("**Lessee**") (collectively the "**Parties**," or individually a "**Party**").

RECITALS

WHEREAS, Lessor owns, operates and maintains certain real property consisting of approximately 4.56 acres, including a parking lot and an approximately 8,000 square foot masonry facilities building that houses communications equipment, commonly known as the Pacific City Cable Station ("**Building**"), located at 33895 Cape Kiwanda Drive, Pacific City, Oregon (collectively, the "**Property**"), as legally described on **Exhibit A**, attached hereto and incorporated by reference herein.

WHEREAS, Lessee desires to lease approximately 4,000 square feet of the Building ("**Premises**"), along with common use of the parking lot and the Property, as more particularly described below.

WHEREAS, Lessor desires to grant to Lessee a lease for the above described Premises in accordance with the terms and conditions of this Lease.

WHEREAS, in conjunction with and as a condition of the lease of the Premises, Lessee and Lessor shall simultaneously enter into an Indefeasible Right of Use License Agreement, as more particularly described below.

NOW, THEREFORE, in consideration of the following mutual exchange of promises and covenants and incorporating the above Recitals as if fully set forth hereinbelow, the Parties agree as follows:

1. LEASED PREMISES

Lessor hereby leases to Lessee, and Lessee hereby leases from Lessor the above described Premises. Lessee shall also have full use of the parking lot and the common areas of the Property, in common with the other tenants, if any. Lessee shall have use of the Premises, as shown on the drawing attached hereto as **Exhibit B** and incorporated by reference herein.

2. OTHER TENANTS

Prior to Lessor leasing any of the other space in the Building to any other tenant, Lessor will offer the space to Lessee and Lessee will have thirty (30) days to decide whether or not Lessee will lease such space. The space will be offered to Lessee under the same terms and conditions as provided in this Lease and for the same Base Rent, subject to the potential Base Rent Reduction described below. If space in the Building is leased to others or others enter into colocation agreements with Lessor, Lessor will ensure that Lessee's space is clearly segregated from that of other tenants and will put in place any security that is reasonably required to ensure no trespass or interference with Lessee's Regional Scale Nodes Project, described in **Section 9**, or use of the Premises. Furthermore, Lessor agrees that it will not lease to any party whose use would interfere with Lessee's use of the Premises.

3. CONDUIT AGREEMENT

In conjunction with this Lease, Lessee and Lessor shall simultaneously enter into an Indefeasible Right of Use License Agreement ("**License Agreement**") for two (2) conduits and related infrastructure, located on the Property, as more particularly described in the License Agreement. In conjunction therewith, Lessor shall provide Lessee with full access to its backhaul bandwidth facilities without connection charges, as more particularly set forth in the License Agreement. Entry into the License Agreement is a critical component of this Lease and is a condition precedent to entering into this Lease.

4. INITIAL TERM & EARLY TERMINATION RIGHTS

This Lease shall be for an initial term of fifteen (15) years ("**Initial Term**"), commencing on the later occurring of within thirty (30) days after the purchase of the Property by Lessor or June 1, 2010 ("**Commencement Date**"), (but in no event later than October 1, 2010), and terminating on December 31, 2025 ("**Initial Term Expiration Date**"). A "**Lease Year**" shall be from January 1 through December 31, provided the first Lease Year will begin on the Commencement Date and end on December 31. Lessee shall have the right to terminate this Lease early, upon the giving of at least ninety (90) days' written notice, if state or federal funding for the Regional Scale Nodes Project is discontinued or Lessee is unable to obtain all building and environmental permits required for installation of all infrastructure and cabling required for the Regional Scale Nodes Project ("**Early Termination Right**"). This Lease is also subject to termination if Lessor, for any reason, terminates the License Agreement or violates the License Agreement so that Lessee does not have use of the conduits and other facilities, as required for Lessee's Permitted Uses, as described in **Section 9**.

5. RENEWAL OPTIONS

Provided no Event of Default has occurred, Lessee shall also have an option to extend the Lease for three (3) additional terms of five (5) years each (each a "**Renewal Option**," and if exercised, each an "**Extension Term**"). All terms of this Lease shall remain exactly the same during any Extension Term. Lessee shall exercise its option for the first Extension Term by giving written notice to Lessor, in accordance with the notice requirements of **Section 30**, not less than ninety (90) days prior to the Initial Term Expiration Date, or, with respect to the exercise of any subsequent Renewal Option, not less than ninety (90) days prior to any Extension Term Expiration Date. Base Rent for each Extension Term will either be mutually agreed upon by the Parties or will be determined by an appraisal, to be conducted by a commercial real estate appraiser who is mutually agreed upon between Lessor and Lessee. The appraised value shall exclude the value of any improvements to the Premises paid for by Lessee. If the Parties cannot agree upon an appraiser, then each Party will hire its own appraiser, and the two appraisers shall appoint a third appraiser who meets the above minimum appraisal criteria. The third appraiser shall select from the appraisals done by the first two appraisers the appraised value which is the closest to the third appraiser's opinion of fair market value. The selected appraised value shall be the Base Rent for the entire Extension Term. Unless a new Base Rent is mutually agreed upon by the Parties for each Extension Period, the foregoing appraisal process shall be followed to re-set the Base Rent for each Extension Period.

6. BASE RENT

Beginning on the Commencement Date and throughout the Initial Term, Lessee shall pay to Lessor a monthly rent payment of Twenty Thousand Dollars ($20,000), due in advance on the first day of each and every month of the Lease Term ("**Base Rent**"). If the Commencement Date is a date other than the first day of the month, Base Rent will be prorated for actual number of days following the Commencement Date during that first initial month. All Base Rent payments shall be made to Lessor at the following address:

Tillamook Lightwave IGA
201 Laurel Ave.
Tillamook, OR 97141
Attn: Paul Levesque

or elsewhere as Lessor may, in writing, from time to time direct. Lessee will also pay the last month's Base Rent, which shall be fixed at Twenty Thousand Dollars ($20,000) due to the early payment. Payment of the first and last Base Rent payment will be made at the closing of the purchase of the Property by Lessor. Base Rent paid is fully refundable on a pro rata basis if this Lease is terminated early for any reason other than a default by Lessee.

7. UTILITIES

Lessee is responsible for installing and paying for Lessee's own telephone, computer systems, sewer, water, and garbage service. Lessee will also pay all electrical utility charges, including HVAC charges, to be billed directly to Lessee. At such time as any party besides Lessee begins to occupy the Building or use the Building utilities, Lessor shall, at Lessor's sole cost and expense, install a separate utility meter to measure Lessee's utility usage, including HVAC charges, so that Lessee may be billed directly from the utility provider. If another tenant is allowed in the Building, Lessor will install separate meters to measure all utilities, at Lessor's cost.

8. POTENTIAL BASE RENT REDUCTION

Lessor has agreed, unless the parties subsequently agree otherwise in writing, that should Lessor lease any of the space in the Building to another tenant for a period of greater than six (6) months for a lower per square foot rent, Lessor will simultaneously either reduce Lessee's Base Rent by twenty percent (20%) or to the equivalent rate of the other tenant, whichever rate is lower.

Furthermore, Lessee has agreed, unless the parties subsequently agree otherwise in writing, that should Lessee sublease any of its space in the Building or any of its use of the Premises to another tenant for a period of greater than six (6) months for a greater per square foot rent, the additional rent received by Lessee over and above the Base Rent will be equally shared with Lessor. In the event of an assignment, all Base Rent will be paid directly to Lessor.

9. USE OF PREMISES

Lessee shall use the Premises for the installation, maintenance, repair and operation of all redundant earth ocean ground anodes and for all uses required for the operation and oversight of its server and network of instruments, undersea cables and moorings (collectively cyber infrastructure) required for its Regional Scale Nodes Project ("**Project**"), which is a part of the national Ocean Observatories Initiative established to more fully capture critical events that influence the path of climate change, the elements of scientific discovery, and the cutting edge opportunities implicit in extending the full power of the Internet to deep ocean robotic colonies in order to study the complex life support systems contained within the ocean ("**Permitted Uses**").

10. PROPERTY TAXES

The parties will cooperate to obtain an exemption from all real property tax assessments against the Premises and all improvements located thereon but if real property taxes are assessed, or if there are any past due real property taxes, then Lessor shall be responsible for the payment of any such taxes. Lessee shall pay any personal property taxes, if any, on its own personal property located on the Premises.

11. CONDITION OF PREMISES

The Premises shall be presented to Lessee in good and clean condition, with all utilities, including but not limited to electrical, HVAC, fire suppression, sewer and water, already in place and in good condition and working order. A certificate of occupancy shall have been issued and shall not have been revoked. Proof of inspection and passage of inspection of the fire suppression system by the fire marshal shall be provided to Lessee. Proof of the most recent inspection and maintenance report of the HVAC system shall also be provided to Lessee. Prior to the Commencement Date, Lessor shall remove all of the existing telecommunications equipment from the Premises, including all equipment racks. Except as provided herein, the Premises shall be empty unless Lessee agrees that some improvements, other than those described in this Lease, may remain in place.

12. COLOCATION RESPONSIBILITIES OF LESSOR

Lessor will maintain and will continuously and constantly supply reliable emergency power generators with related automatic switch gear and a reliable HVAC system. Lessor will also be responsible to bring all existing Building alarm systems up to full operational capacity and to continuously maintain those systems in good operating condition, in order to allow Lessee to monitor temperature and humidity, to detect fuel leaks and to have in place at all times a fully functional fire detection and suppression system. Lessee will be responsible for maintaining Lessee's owned equipment. Lessor will maintain a security perimeter fence around the Property in good condition and repair.

The HVAC system shall be provided twenty-four (24) hours a day, seven (7) days a week without interruption. The HVAC system shall be in compliance with the following specifications 99.9% of the time: (1) average room temperature must be a constant 72° F (or 22° C), with variation of not more than 2° F, plus or minus; and (2) average room humidity must remain a constant 45% with variation of not more than 5%, plus or minus.

13. REMEDIES FOR FAILURE TO PROVIDE OR MAINTAIN UTILITIES

If Lessor fails to continuously maintain the emergency power supply and/or the HVAC system in accordance with the specifications set forth above, then, in addition to the other remedies set forth in **Section 25**, Lessee will be entitled to a reduction of the Base Rent as follows: For every four (4) hours of lost emergency power or lost or noncompliant HVAC system ("**Failure**"), one-half (1/2) day of Base Rent will be automatically deducted from the following month's Base Rent payment, up to a maximum of seven (7) days of Base Rent per month can be deducted. Furthermore, so long as Lessee is the only tenant in the Building, Lessee may exercise self-help to restore the power and/or HVAC system if Lessor fails to do so within twenty-four (24) hours after notice of the outage or noncompliance is provided to Lessor by Lessee. Lessee may notify Lessor of any problems with power or the HVAC system by calling Lessor at the telephone number listed in **Section 30** or by faxing or e-mailing Lessor to the fax number or e-mail address listed therein for Lessor. Base Rent will not begin to be abated until Lessee notifies Lessor of the problem or Lessor discovers the problem on its own, whichever shall occur first.

14. CONDITION OF PREMISES DURING TERM AND AT TERMINATION

Lessor shall maintain the Building and HVAC system in good repair and working condition at all times. Lessee shall maintain Lessee's own equipment installed by Lessee in furtherance of the Project ("**Project Equipment**"). At the expiration or sooner termination of this Lease, Lessee shall remove all Project Equipment unless Lessor and the permits for installation allow it to be left in place. Lessee shall return the Premises to Lessor in at least as good condition as was the condition of the Premises on the Commencement Date, except for ordinary wear and tear based on Lessee's Permitted Uses, damage resulting from a casualty covered by insurance, or damage caused by flood, tidal wave, earthquake, other extraordinary act of nature, or caused by Lessor, including any of Lessor's employees, agents, assigns, lessees (other than Lessee), contractors, subcontractors, licensees, permittees, or invitees.

15. ALTERATIONS AND IMPROVEMENTS

With prior written approval from Lessor, which shall not unreasonably withheld, Lessee shall be entitled, at Lessee's sole expense, to make any improvements to the Premises as are required to fully operate the Project and carry on Lessee's Permitted Uses. Lessee shall ensure that all improvements to the Premises installed by Lessee comply with all applicable state and federal laws. All improvements installed by Lessee shall remain the property of Lessee and shall be removed by Lessee at the expiration or termination of this Lease, unless Lessor and Lessee agree that they may be left in place.

16. HOLDOVER OF PREMISES

Lessee will be entitled to hold over the Premises as long as Lessee pays the then current Base Rent and otherwise abides by the terms of this Lease. Lessor may terminate this holdover option by giving Lessee at least thirty (30) days' written notice that no additional holdover will be allowed.

17. QUIET AND ENJOYMENT BY LESSEE

Lessee, upon complying with and promptly performing all of the terms, covenants and conditions of this Lease on its part to be performed, shall have and quietly enjoy the Premises for the Term set forth herein.

18. ASSIGNMENT AND SUBLETTING

Lessee may assign this Lease to the Consortium for Ocean Leadership, or to any organization designated by the National Science Foundation, without the need for consent of Lessor, but Lessee shall be required to give Lessor at least sixty (60) days' prior written notice of such assignment.

19. INDEMNITY PROVISIONS

Lessor shall indemnify, defend and hold harmless Lessee and the Consortium for Ocean Leadership ("**COL**") and their respective regents, members, directors, officers and employees, to the fullest extent permitted by law, against all claims and expenses (including but not limited to court costs and attorney fees) for loss or damage to any property or injury to or death of any person, in proportion to and to the extent such claims or expenses are caused by or result from the negligent acts or omissions of Lessor or its employees, officers, members, agents or directors.

Lessee shall indemnify, defend and hold harmless Lessor and its members, directors, officers and employees, to the fullest extent permitted by law, against all claims and expenses (including but not limited to court costs and attorney fees) for loss or damage to any property or injury to or death of any person, in proportion to and to the extent such claims or expenses are caused by or result from the negligent acts or omissions of Lessee or its employees, officers, members, agents or directors.

20. LIABILITY INSURANCE

Lessee shall procure and maintain, at its sole cost and expense, during the entire Term of this Lease, the following minimum levels of insurance:

(a) Commercial General Liability insurance or self-insurance, or any combination of arrangements, with a liability limit of Two Million Dollars ($2,000,000) per occurrence, insuring against liability of Lessee and its officers, employees and agents to the extent caused by the performance or failure of performance of duties of Lessee in connection with Lessee's use and occupancy of the Premises; and

(b) Automobile Liability Insurance or self-insurance with combined bodily injury and property damage limits of not less than Two Million Dollars ($2,000,000) for any one occurrence on all owned, leased, hired or nonowned vehicles.

(c) The minimum levels of insurance coverage described in Sections (a) and (b) above shall be periodically increased, as required to meet any increases in the Levels of Liability Coverage under ORS 30.272 or other applicable statute, as the same may be amended from time to time.

Any Commercial General Liability policy shall name Lessor as an additional insured in its capacity as Lessor. The Commercial General Liability policy will afford contractual liability addressing Lessee's indemnity obligations to the extent provided under standard industry policies. The aforesaid policies shall be endorsed to provide for thirty (30) days' notice to Lessor of cancellation or modification and shall be endorsed as primary with respect to any covered risk or liability also insured under a policy paid for by Lessor. Prior to any use of the Premises, Lessee shall furnish Lessor with certificates of insurance evidencing compliance herewith.

21. PROPERTY INSURANCE

Lessor shall procure and maintain, at its sole cost and expense, direct damage property insurance (with fire and extended perils) on the Building with limits not less than the Building's "replacement cost", as such term is defined in the Replacement Cost Endorsement attached to such policy, insuring against physical loss or damage generally included in the classification of "all risk" or "special form" coverage. Lessee shall procure and maintain, at its sole cost and expense, whatever property damage insurance it deems necessary to cover the Project (with fire and extended perils), the Project Equipment and Lessee's other personal property and all improvements that Lessee made to the Premises (collectively "**Lessee Property**"). It is agreed that regardless of fault, Lessee is solely responsible for repairing or replacing any damaged or destroyed Lessee Property. It is agreed that if a loss occurs to the Building and/or to other Lessor owned improvements comprising the Premises, the insurance proceeds must be used by Lessor to repair or replace the damaged Property insured by Lessor unless Lessor and Lessee both agree otherwise. If any part of the Premises is materially damaged so that it is not economically feasible for Lessee to continue this Lease in effect, Lessee may elect to terminate this Lease upon thirty (30) days' written notice to Lessor. If any part of the Premises is damaged and Lessee elects to continue this Lease, the Base Rent shall be equitably abated until the Premises are restored. It is agreed that Lessor is solely responsible for repairing or replacing any damage or destruction to the Property, excluding Lessee Property. It is agreed that Lessee is solely responsible for repairing or replacing any damage or destruction to the Lessee Property.

The Parties agree to mutually waive all right of recovery against the other for loss or damage covered by their respective insurance policies for all perils insured thereunder, and in the event of any insured loss, neither Party's insurance carrier will have a subrogation claim against the other Party; provided, however, that this waiver shall not apply if the effect is to void such insurance coverage.

22. COMPLIANCE WITH APPLICABLE LAWS

Lessee agrees to obtain all necessary permits and comply with all applicable federal, state and local laws, rules, regulations and standards promulgated thereunder and all permits (including Lessee's NPDES permit) relating to the Premises or Lessee's operations and activities on the Premises. If Lessee is found to be out of compliance with any applicable law or permit, Lessee will not be considered to be in default under this provision provided that Lessee is making good faith efforts to remedy the noncompliance or pay any civil penalties and Lessor is not subject to any enforcement action (including, without limitation, any cease and desist order, stop work order, or penalty assessment or any other type of enforcement action, whether similar or not) resulting from Lessee's noncompliance. Lessee represents and warrants to Lessor that Lessee has a valid NPDES permit for its operations at the Premises and Lessee shall maintain such permit, including amendments thereto.

23. LESSOR'S RIGHT OF INSPECTION

Lessor shall have the right to inspect the Premises at all reasonable times during Lessee's normal business hours and upon the giving of reasonable advance notice to Lessee so that Lessee can arrange for one of Lessee's representatives to accompany Lessor. Lessor understands that complex operations will be occurring on the Premises and that Lessor will be required to abide by Lessee's safety protocol and to be accompanied by a representative of Lessee during such inspection for safety and operational reasons. The right of inspection reserved to Lessor hereunder shall impose no obligation on Lessor to make inspections to ascertain the condition of the Premises, and shall impose no liability upon Lessor for failure to make such inspections.

24. EVENT OF DEFAULT BY LESSEE

An "**Event of Default**" shall be deemed to have occurred if Lessee fails to pay Base Rent within ten (10) days after written notice from Lessor stating that the payment is past due. A late charge of three percent (3%) of any payment that is not paid when due under this Lease shall be paid by Lessee. An Event of Default shall also be deemed to have occurred if Lessee violates any other term, covenant or condition of this Lease (other than the foregoing failure to pay Base Rent) and such failure is not cured within thirty (30) days after receipt of written notice from Lessor to Lessee describing the nature of the violation. Provided, however, if the violation is of such a nature that it cannot reasonably be cured within such thirty (30) day period, the cure period shall be reasonably extended to allow adequate time to allow Lessee to complete the cure and avoid the Event of Default.

25. EVENT OF DEFAULT BY LESSOR

An Event of Default shall also be deemed to have occurred if Lessor violates any term, covenant or condition of this Lease and such violation is not cured within thirty (30) days after receipt of written notice from Lessee to Lessor describing the nature of the violation. Provided, however, if the violation is of such a nature that it cannot reasonably be cured within such thirty (30) day period, the cure period shall be reasonably extended to allow adequate time to allow Lessor to complete the cure and avoid the Event of Default.

26. REMEDIES FOR DEFAULT

If an Event of Default, as provided above, shall occur, the non-defaulting Party shall be entitled to seek any and all remedies available at law or in equity for breach of contract, including recovery of actual damages (plus interest thereon) but excluding special, consequential and punitive damages. Notwithstanding the foregoing, because of the nature of the Project and the federal funding involved, the Parties expressly waive the right to terminate this Lease due to an Event of Default as long as the Event of Default can be cured through self-help. Following an Event of Default, the non-defaulting Party may elect to exercise self-help in order to cure any Event of Default and charge the defaulting Party for the cost of effecting such cure (including attorney fees and costs), in an amount equal to one hundred percent (100%) of the reasonable costs incurred to effect such cure ("**Cure Cost**"). The Cure Cost will also bear an interest rate of ten percent (10%) per annum. Lessee may offset such Cure Costs against Base Rent due until Lessee has been paid in full. It is hereby agreed that the non-defaulting Party will not be allowed to exercise self-help without first notifying the defaulting Party of the intent to exercise self-help. After such notice is given, self-help may not be exercised for ten (10) days after delivery of the notice or until the defaulting Party's applicable cure period for curing the default has expired and the Event of Default has thereby occurred, whichever shall occur later. Notwithstanding the above right to exercise self-help in order to cure an Event of Default, neither Party will have any obligation to exercise self-help.

27. SIGNS

No signs or other advertising matter, symbols, canopies, or awnings shall be attached to or painted on or within the Premises, including the windows and doors thereof, without the written approval of Lessor first had and obtained, which approval shall not be withheld as long as the signage is in compliance with Tillamook County code requirements and does not substantively conflict with the uses of the Building by Lessor's other tenants. At the termination or sooner expiration of this Lease, all such signs, advertising matter, symbols, canopies or awnings attached to or painted by Lessee shall be removed by Lessee at its own expense, and Lessee shall repair any damage or injury to the Premises, and correct any unsightly conditions, caused by the maintenance and removal of said signs, etc.

28. PROHIBITION AGAINST LIENS AND ENCUMBRANCES

Lessee shall keep the Premises, and any improvements placed thereon (except for improvements made by Lessee which are removable), free and clear of any liens and encumbrances arising or growing out of the use and occupancy of the Premises by Lessee hereunder. If requested, Lessee shall furnish to Lessor lien waivers for work performed by any contractors retained by Lessee who perform services upon the Premises.

29. NONWAIVER

Neither the acceptance of Rent nor any other act or omission of Lessor at any time or times after the happening of an occurrence of a violation of this Lease or the occurrence of an actual Event of Default shall operate as a waiver of any past or future violation, breach or failure to keep or perform any covenant, agreement, term or condition hereof or to deprive Lessor from promptly exercising any other option, right or remedy that it may have under any term or provision of this Lease.

30. NOTICE REQUIREMENTS

Any notices required in accordance with any of the provisions herein may be personally delivered or, if mailed, shall be sent by overnight mail with delivery receipt or by certified mail, return receipt requested, addressed to:

To Lessor: Tillamook Lightwave IGA
201 Laurel Ave.
Tillamook, OR 97141
Attn: Paul Levesque
Telephone: 503.842.1809
Facsimile: 503.842.1384
E-mail: plevesqu@co.tillamook.or.us

To Lessee: University of Washington
UW RSN Operations
Attn: Brian Ittig
909 Boat Street NE
Seattle, WA 98105
Telephone: 206.616.6792
Facsimile: 206.221.6771
E-mail: bittig@u.washington.edu

Notices sent by certified mail shall be deemed received five (5) days after having been placed in the United States mail, postage paid. Notices sent by overnight delivery shall be deemed received upon delivery and proof thereof.

31. ENVIRONMENTAL MANAGEMENT AND COMPLIANCE

(a) Definitions. For the purposes of this Lease, the following definitions shall apply.

(i) "**Environmental Audit**" means a mutually agreeable environmental site assessment and compliance audit satisfying, at a minimum, all appropriate inquiry requirements of the Comprehensive Environmental Response, Compensation and Liability Act, as amended, 42 U.S.C. § 9601, et. seq ("**CERCLA**") Section 101(35)(B) (42 U.S.C. § 9601(35)(B)), 40 CFR Part 312, ORS 465.255(6), and American Society of Testing Materials ("**ASTM**") Standard E1527-05 (Standard Practice for Environmental Site Assessments: Phase 1 Environmental Site Assessment Process), and any other compliance assessment or auditing standards, including ASTM Standard E2107-00 (Standard Practice for Environmental Regulatory Compliance Audits), relevant and appropriate to Lessee's Permitted Uses, or the successors to any of these criteria or standards. If such environmental audit recommends additional evaluation, testing or analysis, or recommends an additional audit, then the Environmental Audit shall include the additional evaluation, testing or analysis scoped and performed in accordance with commercially reasonable practices.

(ii) "**Environmental Costs**" means damages, fines, costs, penalties, and fees arising from any Hazardous Substance Release or any violation of or noncompliance by either Party in any material respect with (a) any applicable Environmental Laws, or (b) any of the environmental provisions of this Lease, and includes required costs of immediate response, remediation, and restoration actions, natural resources damages, oversight and participation costs of governmental agencies, including natural resources trustees, reasonable and documented fees and costs of project managers, attorneys, legal assistants, engineers, consultants, accountants, and experts, whether or not employees of the damaged Party and whether or not taxable as costs, incurred prior to, at or after any administrative or judicial proceeding, including appeals and other forms of judicial review.

(iii) "**Environmental Laws**" shall include any and all applicable federal, State of Oregon, regional and local laws, regulations, rules, permit terms, codes, ordinances and legally enforceable guidance documents, now or hereafter in effect, as the same may be amended from time to time, and applicable decisional law, which govern materials, substances, regulated wastes, emissions, pollutants, water, storm water, ground water, wellfield and wellhead protection, cultural resources protection, animals or plants, noise, or products and relate to the protection of health, safety or the environment and natural resources, including land, sediments, water, ground water and storm water.

(iv) "**Hazardous Substance**" shall include any and all substances, emissions, pollutants, contaminants, materials or products defined or designated as hazardous, toxic, radioactive, dangerous or regulated wastes or materials or any other similar term in or under any applicable Environmental Laws. Hazardous Substance shall also include, but not be limited to, fuels, bio-fuels, petroleum and petroleum-derived products.

(v) "**Hazardous Substance Release**" shall include the spilling, discharge, deposit, injection, dumping, emitting, releasing, placing, leaking, migrating, leaching, and seeping of any Hazardous Substance by either Party into the air or into or on any land, sediment or waters, in excess of an actionable level, except any release in compliance with Environmental Laws or specifically authorized by a current and valid permit issued under Environmental Laws with which the Responsible Party (as defined below) is in compliance at the time of such release.

(b) General Environmental Obligations of the Parties. Lessor and Lessee shall each manage and conduct all of its activities on or relating to the Property in compliance with all applicable Environmental Laws and the environmental provisions of this Lease.

(c) Initial Audit; Environmental Information. Prior to the Commencement Date of this Lease, an Environmental Audit of the Property was jointly scoped and commissioned by Lessor and Lessee and was conducted by Statewide Environmental Services. The results of the Environmental Audit are contained in the report titled "Level I Environmental Site Assessment" and dated April 23, 2010, which shall be deemed to be a part of this Lease and incorporated herein for all purposes by this reference. Lessor and Lessee have reviewed and accepted the Environmental Audit. Lessor and Lessee acknowledge that in connection with this Lease, the Environmental Audit shall be used as information to assist in determination of future environmental liability, if any, between Lessor and Lessee. The Environmental Audit may also be used by Lessee to establish a protected lessee defense under state and federal environmental laws.

(d) Remediation.

(i) Releases and Violations. In the event of a violation of any applicable Environmental Laws, a violation of any environmental provision of this Lease, or a Hazardous Substance Release, for which Lessor or Lessee (each, for purposes of this **Section 31**, a "**Responsible Party**") is responsible under this Lease, the Responsible Party shall undertake promptly, or sooner if required by Environmental Laws, all acts necessary or appropriate to respond to, investigate, contain and/or stop the violation, Hazardous Substance Release or source of the threat in accordance with the provisions of this **Section 31**.

(ii) Remediation and Removal. The Responsible Party shall promptly undertake, at its sole expense, all remedial and/or removal actions necessary or appropriate to ensure that (1) any Hazardous Substance is addressed, removed and/or any Hazardous Substance Release on or in the Property is remediated to a promulgated regulatory cleanup standard applicable to the particular Hazardous Substance, if such standard has been established by the federal and state authorities; provided, however, that as long as allowed under Environmental Laws, the cleanup standard for the Lease shall be cleanup to the cleanup criteria applicable to the industrial use of the Property; and (2) any violation of any Environmental Laws or environmental provision of this Lease is cured or corrected. In the absence of the applicability of a promulgated regulatory cleanup standard or the conditional criteria stated above, the regulatory authorities shall determine the applicable cleanup standard, after input from both the Responsible Party and the other Party hereto, consistent with the Permitted Uses. In the event that any remediation or removal required by this Lease cannot reasonably be completed prior to the termination or expiration of this Lease, if the Responsible Party is Lessee, Lessee shall not be in default of its remediation obligations so long as it promptly commences and continues all necessary and appropriate investigation, containment, remediation and removal activities and completes these activities promptly using continuous due diligence (or sooner if required by Environmental Laws).

(iii) Hazardous Substance Releases That Must Be Removed to Allow Construction. In the event that during construction of Lessee's improvements, including cyber infrastructure and underground cabling, Lessee discovers a pre-existing Hazardous Substance Release or violation of Environmental Laws not caused by Lessee that must be removed in order to allow Lessee to safely complete construction, installation or repair of any facilities or improvements needed for Lessee's Permitted Uses, Lessor will, immediately upon notice of such discovery of a Hazardous Substance, assume all responsibility for the prompt and proper clean-up, management and disposal of such Hazardous Substances, as is required by law. Oversight of such remediation may be requested of or required by the Oregon Department of Environmental Quality ("**DEQ**").

(iv) Approval Rights. The Party that is not the Responsible Party shall have the right and a reasonable opportunity to review and comment on all investigatory, remediation and removal procedures within the Property or adjoining water which are required by this **Section 31** or by any Environmental Laws, to ensure that the investigation, remediation or removal, as applicable, is completed in a manner and according to a schedule that is reasonably consistent with Lessee's Permitted Uses under this Lease.

(e) Notice. Each Responsible Party shall notify the other Party promptly, and in compliance with any applicable time periods required by Environmental Laws, upon becoming aware of (i) a violation or alleged violation of any Environmental Laws related to the Property; (ii) any Hazardous Substance Release on or in the Property; and (iii) any notice or communication from a governmental agency relating to any Hazardous Substance Release or any violation or alleged violation of any Environmental Laws which relate to the Property.

(f) Non-Responsible Party's Right to Perform on Behalf of a Responsible Party. If a Responsible Party fails to respond to a Hazardous Substance Release for which it is responsible within the Property and such failure to perform materially interferes with the rights under this Lease of the other Party ("**Non-Responsible Party**"), the Non-Responsible Party shall have the right, but not the obligation, upon giving the Responsible Party ten (10) days' written notice (or less time if necessary for the Responsible Party to remain in compliance with such order) ("**Notice Period**") to perform such actions as are reasonably necessary to allow Lessee to continue its Permitted Uses. The Non-Responsible Party shall be entitled to charge the Responsible Party for all necessary Environmental Costs ("**Self Help**") in accordance with this **Section 31(f)**. Such notice shall include a statement of the Non-Responsible Party's demands and detailed justification thereof, including relevant documentation. The Non-Responsible Party may not commence performance on behalf of the Responsible Party under this **Section 31(f)** if, during the Notice Period, the Responsible Party promptly begins and diligently pursues to completion the performance of the obligations set forth in the Non-Responsible Party's notice. Within sixty (60) days of submission of written demand from the Non-Responsible Party, the Responsible Party shall reimburse the Non-Responsible Party for its expended Environmental Costs in full. If the Responsible Party contests the work performed or the amount spent as unreasonable, the Responsible Party must either pay the full amount under protest and subject to full or partial refund upon resolution of the dispute or, in the alternative, must immediately reimburse the uncontested amount and at the same time provide written justification of any items excluded from reimbursement, or clearly and finally deny liability and explain in detail, in writing, the reason for such denial with specific proof offered to justify the denial. This right of Self Help is in addition to and not lieu of the rights granted to the Non-Responsible Party in **Section 13**. Any amount later deemed to be due and owing will bear interest from the date expended at the rate of ten percent (10%) per annum.

(g) Time Frames. All time frames stated in this **Section 31** may be extended by mutual written agreement of the Parties, provided such extensions do not violate any Environmental Laws.

(h) Lessor's Environmental Indemnity. Lessor agrees, to the extent allowed by Oregon law, to defend (using legal counsel reasonably acceptable to Lessee), indemnify, hold harmless, and reimburse Lessee for, from and against any and all demands, notices of claim or notices of violation, claims, actions (whether administrative or judicial) or suits by third parties for injunctive relief under Environmental Laws or for Environmental Costs (collectively "**Environmental Claims**") imposed upon or claimed against Lessee to the extent arising from a Hazardous Substance Release to or in the Property, caused by, contributed to or exacerbated by

Lessor. For purposes of this **Section 31**, the term "Lessor" shall be deemed to include Lessor and its partners, officers, directors, agents, employees, licensees, invitees, contractors, and subcontractors.

(i) Lessee's Environmental Indemnity. Lessee agrees, to the extent allowed by Washington law, to defend (using legal counsel reasonably acceptable to Lessor), indemnify, hold harmless, and reimburse Lessor for, from and against Environmental Claims imposed upon or claimed against Lessor to the extent arising from a Hazardous Substance Release on, in, or affecting the Property caused by, contributed to or exacerbated by Lessee. For purposes of this **Section 31**, "Lessee" shall be deemed to include Lessee and its partners, officers, directors, agents, employees, licensees, invitees, contractors, and subcontractors. Notwithstanding the foregoing, Lessee will not be responsible for and will not indemnify Lessor for the exacerbation of a pre-existing Hazardous Substance Release unless Lessee has been made aware of such Hazardous Substance Release by Lessor or by the Environmental Audit. If Lessee discovers such a Hazardous Substance Release, it will immediately cease work in that facility and notify Lessor, who will be responsible to promptly respond and remediate such pre-existing Hazardous Substance Release.

(j) Lessor acknowledges that the National Science Foundation ("**NSF**") must satisfy its compliance obligations under federal environmental laws, including the National Environmental Policy Act, 42 U.S.C. §§ 4321, et seq., the National Historic Preservation Act, 16 U.S.C. §§ 470, et seq., and the Endangered Species Act, 16 U.S.C. §§ 1531, et seq. Lessor shall cooperate to the fullest extent possible with NSF's efforts to meet those obligations. Lessor shall not undertake any activity that is subject to federal environmental laws until NSF has satisfied its environmental compliance obligations, as evidenced in writing by the NSF Grants and Agreements Officer.

32. RIGHTS AND DUTIES OF SUCCESSORS AND ASSIGNS

All the terms, covenants, and agreements of this Lease shall be binding upon Lessor, Lessee, and their respective successors and assigns, and upon each person or persons coming into ownership or possession of the Premises by operation of law or otherwise.

33. CONDEMNATION & LOSS OF USE

If all the Premises are taken by any public authority under the power of eminent domain, this Lease shall terminate as of the date possession is taken by said public authority pursuant to such condemnation.

If any part of the Premises is so taken and, in the reasonable opinion of Lessee, it is not economically feasible to continue this Lease in effect, Lessee may terminate this Lease. Such termination shall be made by notice to Lessor given not later than thirty (30) days after possession is taken, the termination to be effective as of the later of thirty (30) days after said notice or the date possession is so taken.

If part of the Premises is so taken, and Lessee elects to terminate this Lease, or until termination is effective, as the case may be, Base Rent shall be abated in the same proportion of the Premises so taken bears to the whole of the Premises. All damages awarded for the taking or damaging of all or any part of the Premises shall belong to and be the property of Lessor, and Lessee hereby assigns to Lessor any and all claims to such award, but nothing herein contained shall be construed as precluding Lessee from asserting any claim Lessee may have against such public authority for loss of improvements made and paid for by Lessee that Lessee is entitled to remove and is not able to move or reuse, disruption or relocation of Lessee's business, and for moving expenses.

In the event it is claimed or adjudged that any improvements covered by this Lease, other than those placed on the Premises by Lessee, encroach on adjoining property and that any adjoining property owner is entitled to receive charges, fees, assessments, or other payments for such encroachment, then Lessor shall indemnify, defend, reimburse and hold Lessee harmless from all such charges, fees, assessments and other payments. Furthermore, if as a result of such adjudication Lessee is prevented access to the ocean or Lessee loses the right to use or have access to any material portion of the Premises, then Lessee shall have the option to terminate this Lease. Base Rent shall be abated for any reduction in the Premises, including water access, either on a permanent or temporary basis. In the event there becomes lack of water access to the Premises to a point that significantly inhibits Lessee's Permitted Uses, Lessee shall be entitled to terminate this Lease, unless such water access can be reasonably and timely restored by Lessor.

34. GOVERNING LAW AND JURISDICTION

This Lease shall be governed and construed according to the laws of the State of Oregon, without regard to its choice of law provisions. The Parties hereby willingly agree that any action or suit to enforce or construe any provision of this Lease by either Party must be brought in the Circuit Court of the State of Oregon in Tillamook County, or the U.S. District Court for the District of Oregon located in Portland, Oregon. The foregoing courts shall have exclusive jurisdiction over all lawsuits brought by either Party against the other with respect to the subject matter of this Lease, and each Party hereby irrevocably consents to such exclusive jurisdiction and waives any and all objections it might otherwise have with respect thereto.

35. CONSENT OR ACTION

In the event this Lease is silent as to the standard for any consent, approval, determination, or similar discretionary action, the standard shall be the reasonable discretion of the Party, rather than any sole discretion standard.

36. TIME OF THE ESSENCE

Time is of the essence in the performance of and adherence to each and every covenant and condition of this Lease.

37. SURVIVAL

Any covenant or condition set forth in this Lease, which, by its nature or by its terms, is to survive the expiration or termination of this Lease, shall survive the expiration or earlier termination of this Lease and shall remain fully enforceable thereafter.

38. PARTIAL INVALIDITY

If any provision of this Lease is held to be invalid or unenforceable, the remainder of this Lease, or the application of such provision to persons or circumstances other than those to which it is held invalid or unenforceable, shall not be affected thereby, and each provision of this Lease shall be valid and enforceable to the fullest extent permitted by law.

39. HEADINGS

The Section headings contained in this Lease are for convenience in reference and are not intended to define or limit the scope of any provision of this Lease.

40. EXHIBITS INCORPORATED BY REFERENCE

All Exhibits attached to this Lease are incorporated by reference in this Lease for all purposes.

41. MODIFICATION

This Lease may not be modified except by a writing signed by Lessor and Lessee.

42. BROKERS

Lessee and Lessor each represent to one another that they have not dealt with any leasing agent or broker in connection with this Lease and each agrees to indemnify and hold harmless the other from and against all damages, costs, and expenses (including attorney, accountant and paralegal fees) arising in connection with any claim of an agent or broker alleging to have been retained by the other in connection with this Lease.

43. ATTORNEY FEES

If a suit, action, or other proceeding of any nature whatsoever (including any proceeding under the U.S. Bankruptcy Code) is instituted in connection with any controversy arising out of this Lease or to interpret or enforce any rights or obligations hereunder, the prevailing Party shall be entitled to recover attorney, paralegal, accountant, and other expert fees and all other fees, costs, and expenses actually incurred and reasonably necessary in connection therewith, as determined by the court or body at trial or on any appeal or review, in addition to all other amounts provided by law. Payment of all such fees shall also apply to any administrative proceeding, trial, and/or any appeal or petition for review. Whenever this Lease requires one Party to defend the other Party, it is agreed that such defense shall be by legal counsel acceptable to the Party to be defended, understanding that claims are often covered by insurance with the insurance carrier designating the defense counsel.

44. DEFINED TERMS

Capitalized terms shall have the meanings given them in the text of this Lease.

45. PERFORMANCE UNDER PROTEST

In order to avoid being declared in violation, breach, or default under this Lease, either Party may elect to perform, as required by the other Party, but shall preserve its right to contest its obligation to so perform and to recover against the other Party if it is later determined that such performance was, in fact, not required.

46. FORCE MAJEURE

The time for performance of any of Lessee's or Lessor's obligations hereunder shall be extended for a period equal to any hindrance, delay or suspension in the performance of that Party's obligations, beyond the Party's reasonable control and directly impacting the Party's ability to perform, caused by any of the following events: Unusually severe acts of nature, including floods, earthquakes, hurricanes and other extraordinary weather conditions; civil riots, war, terrorism, or invasion; any delay occurring in receiving approvals or consents from any governmental authority, including the DEQ, the U.S. Environmental Protection Agency or other agency review of environmental reports (so long as an application for such approval or consent was timely filed and thereafter diligently pursued); major fire or other major unforeseen casualty; labor strike that precludes the Party's performance of the work in progress; extraordinary and unanticipated shortages of materials, or significant changes in the law (each a "**Force Majeure Event**"). Lack of funds or willful or negligent acts of a Party shall not constitute a Force Majeure Event hereunder. Further, it shall be a condition to any extension of the time for a Party's performance hereunder that such Party notify the other Party within five (5) business days following the occurrence of the Force Majeure Event and diligently pursue the delayed performance as soon as is reasonably possible.

47. LIMITATION ON LIABILITY

Lessee's obligation under this Lease to make all Base Rent and other payments is payable solely from the revenues of Lessee. This Lease and the Base Rent and other payment obligations hereunder shall not constitute an obligation of the State of Washington, moral or otherwise, for which the State of Washington is obligated to levy or pledge any form of taxation. Neither the Lease nor the Base Rent or other payment obligations hereunder constitute a pledge of the full faith and credit of the State of Washington within the meaning of the Constitution of the State of Washington or within the meaning of any statutory debt limitation or restriction. If the Washington Legislature or the funding agency allots or grants insufficient funds to continue Base Rent or other payments under this Lease, in the judgment of Lessee, for the remainder of the current fiscal period, or for a succeeding fiscal period, by appropriation, appropriation limitation, termination of grant or contract, or otherwise, then, upon written notice from Lessee to Lessor, this Lease shall terminate and the obligation of Lessee to make Base Rent or other payments from money available to it shall terminate on the date on which, under the terms of the appropriation, appropriation limitation, or termination of grant or contract, moneys will no longer be allotted for this Lease, without penalty, and such lease termination shall not constitute an Event of Default.

Similarly, Lessor's obligations under this Lease are payable solely from the revenues of Lessor. This Lease and other payment obligations hereunder shall not constitute an obligation of the State of Oregon or of any of Lessor's constituent members, moral or otherwise, for which the State of Oregon or any of Lessor's constituent members are obligated to levy or pledge any form of taxation. Neither the Lease nor other payment obligations hereunder constitute a pledge of the full faith and credit of the State of Oregon or of any of Lessor's constituent members within the meaning of the Constitution of the State of Oregon or within the meaning of any statutory debt limitation or restriction. Under no circumstances shall Lessor's member bodies be jointly or severally liable for any of Lessor's obligations hereunder; Lessor's obligations are those of Lessor alone.

48. NONDISCRIMINATION

This Lease is subject to the provisions of Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d) and the regulations issued pursuant thereto (45 CFR § 611). No person on the basis of race, color, national origin, or handicap shall be excluded from participation in, be denied benefits of, or otherwise be subjected to discrimination in the Project. In addition, if the Project involves an education activity or program, as defined by Title IX of the Education Amendments of 1972 (20 U.S.C. §§ 1681, 1682, 1683, 1684, 1685, 1686), no person on the basis of sex shall be excluded from participation in the Project. Further, Lessor and Lessee will comply with Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. §794) and implementing regulations (45 CFR §605).

49. CAPACITY TO EXECUTE; MUTUAL REPRESENTATIONS

Lessor and Lessee each warrant and represent to one another that this Lease constitutes a legal, valid and binding obligation of that Party. Without limiting the generality of the foregoing, each Party represents that its governing board has authorized the execution, delivery and performance of this Lease by it. The individuals executing this Lease warrant that they have full authority to execute this Lease on behalf of the entity for whom they purport to be acting. Each Party represents to the other that neither the execution and the delivery of this Lease, nor the consummation of the transaction contemplated hereby will: (a) violate or conflict with any constitution, statute, regulation, rule, injunction, judgment, order, decree, ruling, charge, or other restriction of any government, government agency or court to which it is subject or any provision of its charter or bylaws; or (b) conflict with, result in a breach or constitute a default under any other agreement to which it is a party or by which it is bound. Neither Party needs to give any notice to, make any filing with, or obtain the consent of any party to consummate the transaction contemplated by this Lease.

50. NONDISTURBANCE AGREEMENT

Lessor agrees that Lessor will cause any lender with an interest in the Property to execute a nondisturbance agreement in favor of Lessee.

51. FLOW DOWN PROVISION

The Project is funded under a cooperative agreement between COL and NSF. Accordingly, and as required by section G.6.11 of the agreement between COL and the University of Washington, certain terms and conditions found in the agreement between COL and the University of Washington must and shall apply to this Lease. The following provisions of NSF Financial/Administrative Terms and Conditions (http://www.nsf.gov/pubs/gc1/

cafatc_jan10.pdf) shall apply to this Lease, Articles 12, 17, 21, 24, 25, 28, 29, 32, 35, 36 and 40. In addition, the terms and conditions set forth in **Appendix 1**, which is attached hereto and incorporated herein by this reference, shall apply to this Lease.

51. COUNTERPARTS

This Lease may be may be executed by the Parties in separate counterparts, each of which when executed and delivered shall be an original, but all of which together shall constitute one and the same document.

[*Remainder of this page intentionally left blank; signatures appear on following page.*]

IN WITNESS WHEREOF, the Parties hereto have executed this Lease the day and year first above written.

LESSOR:

TILLAMOOK LIGHTWAVE IGA

By: ______________________

Print Name: Paul Levesque

As Its: President

LESSEE:

BOARD OF REGENTS OF THE UNIVERSITY OF WASHINGTON

By: ______________________

Print Name: ~~Jeanette Henderson~~ Steve Kennard

As Its: ~~Real Estate Office Director~~ Assistant Director, Asset Management

Approved As To Form:

____

Special Assistant Attorney General

PO-332609 v1

LESSOR ACKNOWLEDGMENT

STATE OF OREGON)
) ss
COUNTY OF TILLAMOOK)

I certify that I know or have satisfactory evidence that Paul Levesque is the person who appeared before me and said person acknowledged that s/he signed this instrument, on oath stated that s/he was authorized to execute the instrument and acknowledged it as the President of Tillamook Lightwave IGA, for the uses and purposes mentioned in the instrument.

Dated: May 19, 2010

Elaine Mallett
Notary Public
Print Name Elaine Mallett
My commission expires 1-5-2012

OFFICIAL SEAL
ELAINE MALLETT
NOTARY PUBLIC-OREGON
COMMISSION NO. 422659
MY COMMISSION EXPIRES JANUARY 5, 2012

LESSEE ACKNOWLEDGMENT

STATE OF WASHINGTON)
) ss
COUNTY OF KING)

I certify that I know or have satisfactory evidence that Jeanette Henderson is the person who appeared before me and said person acknowledged that she signed this instrument, on oath stated that she was authorized to execute the instrument and acknowledged it as the Real Estate Office Director of the University of Washington, as approved by the Board of Regents of the University of Washington, for the uses and purposes mentioned in the instrument.

Dated: ____________________

____
Notary Public
Print Name ____________________
My commission expires ____________

STATE OF WASHINGTON)
COUNTY OF KING)

On this 28th day of May, 2010, before me personally appeared **Steve Kennard**, to me known as the **Assistant Director, Asset Management** of the Real Estate Office of the University of Washington, who on oath stated that he was authorized to execute this instrument and acknowledged it to be the free and voluntary act and deed of said University of Washington as approved by the **BOARD OF REGENTS OF THE UNIVERSITY OF WASHINGTON** for the uses and purposes mentioned in the instrument.

Signature: KD Fortenbacher
Printed Name: Katherine D. Fortenbacher
Notary Public in and for the State of Washington
Residing at: Mill Creek, WA
My Commission expires on: 08/28/2012

KATHERINE D. HAAG Fortenbacher
COMMISSION EXPIRES
NOTARY
KDF
PUBLIC
AUG. 28, 2012
STATE OF WASHINGTON

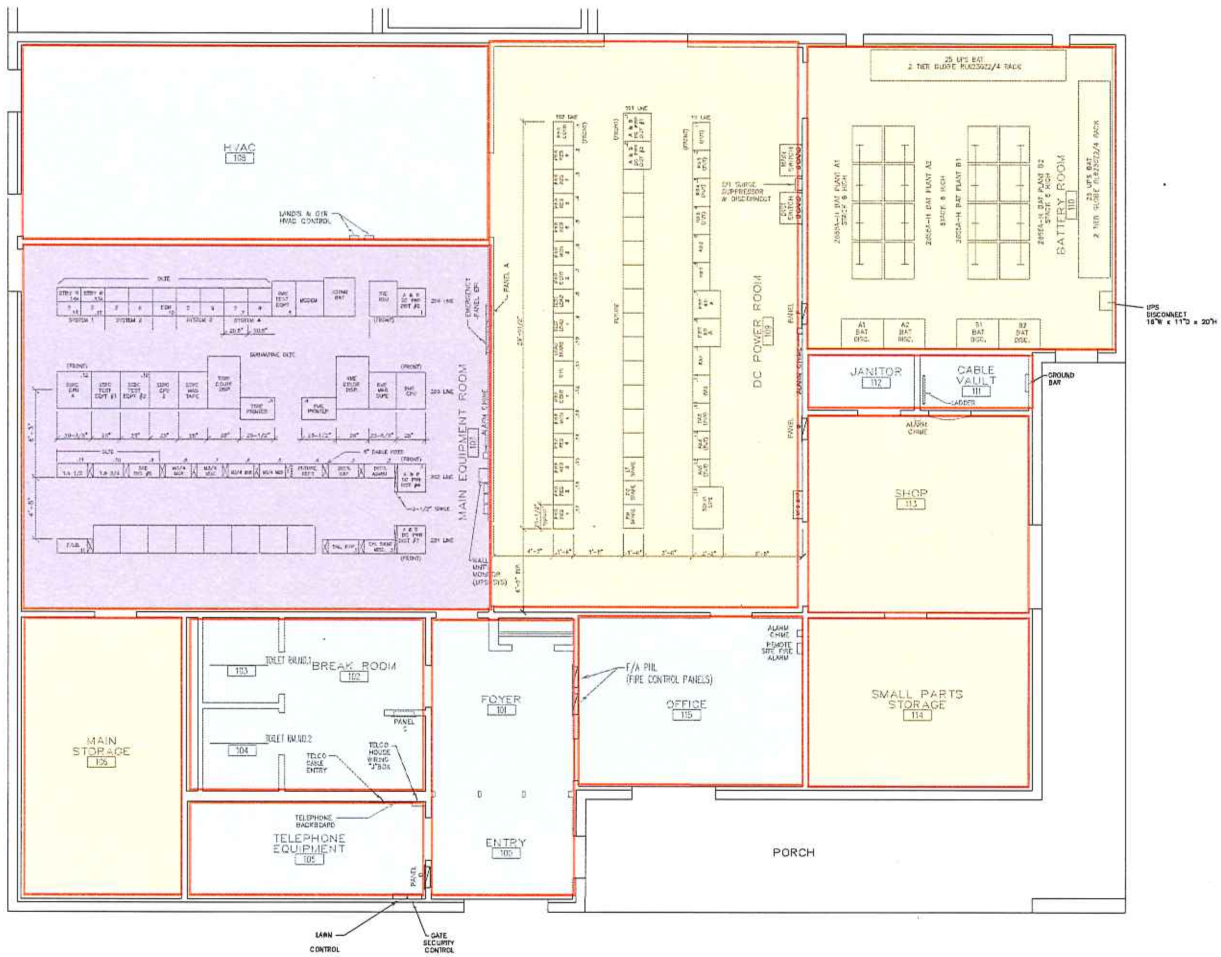
EXHIBIT A

Legal Description of Property

A tract of land lying in the Northeast one-quarter of Section 24, Township 4 South, Range 11 West of the Willamette Meridian, in Tillamook County, Oregon, said parcel of land being a portion of that certain tract of land conveyed to Kenneth F. Spooner, et ux, by deed recorded in Book 233, Page 428, Tillamook County Deed Records, said parcel of land being more particularly described as follows to-wit:

Beginning at an iron rod which marks the Southeasterly corner of Lot 6, Block 5, Webb's Subdivision, in Section 24, Township 4 South, Range 11 West of the Willamette Meridian, Tillamook County, Oregon, and running thence North 27° 17' 00" West, along the Easterly line of the aforesaid Block 5 of Webb's Subdivision, a distance of 100.00 feet to an iron rod at the Southeasterly corner of Lot 8 of said Block 5 of Webb's Subdivision; thence South 62° 43' 00" West, along the Southerly line of said Lot 8, a distance of 100.00 feet to the Southwesterly corner thereof; thence North 27° 17' 00" West, along the Westerly line of said Lot 8, a distance of 50.00 feet to the Northwesterly corner thereof; thence North 62° 43' 00" East, along the Northerly line of said Lot 8, a distance of 100.00 feet to an iron rod at the Northeasterly corner thereof; thence North 27° 17' 00" West, along the Easterly line of the aforesaid Block 5 of Webb's Subdivision, a distance of 150.00 feet to an iron pipe at the Northeasterly corner of Lot 11 of the aforesaid Block 5, said point also being the most Southerly Southwest corner of that certain tract of land conveyed to Julio G. Gogas, Sr. and Jean E. Gogas, husband and wife, by deed recorded in Book 312, Page 322, Parcel II, Deed Records for Tillamook County, Oregon; thence North 62° 45' 40" East, along the Southerly line of the Gogas tract and the Northeasterly extension thereof a distance of 518.97 feet to an iron rod at the most Easterly corner of that certain tract of land conveyed to Julio G. and Jean Elaine Gogas, Sr. by deed recorded in Book 284, Page 809, Deed Records for Tillamook County, Oregon, said point also being in the South line of that certain tract of land conveyed to Marjorie J. Johnston, by deed recorded in Book 316, Page 840, Parcel I, Deed Records for Tillamook County, Oregon; thence North 89° 58' 45" East, along said Southerly line of the Johnston Tract, a distance of 217.22 feet to an iron rod in the East line of the aforesaid Section 24, Township 4 South, Range 11 West of the Willamette Meridian, Tillamook County, Oregon; thence South 00° 13' 25" West, along said East line of Section 24, a distance of 226.13 feet to an iron rod; thence South 62° 45' 40" West, parallel with the aforesaid Southerly line of the Gogas tracts, a distance of 607.61 feet to the point of beginning.

REV.	DESCRIPTION	PROJ/SPEC.	DFT.	APPD.	DATE
1	FIRST ISSUE	880106	RCC	CR	07/89
2	REVISED DC POWER ROOM & MAIN EQPT. ROOM	880106	FJC	CR	09/89
3	REVISED BATTERY ROOM, LINES 10,101,102 PER MARKED PRINT	880104	RCC	CE	02/90
4	REVISED DRAWING PER MARKED PRINT	880104	RCC	CE	03/90
5	REVISED DRAWING PER MARKED PRINT	880104	RCC	CE	04/90
6	REVISED DRAWING PER MARKED PRINT	880106	RCC	CE	06/90
7	REVISED LINES 201, 202, & 204 PER FRONT EQUIPMENT LAYOUT	880105	RCC	CE	07/90
8	ADDED RR202.5 & RR202.6 EQPT. ADDED RR201.3	880105	PO	CE	09/90
9	ADDED ALARM CHIME, REMOTE SITE FIRE ALARM & LANDIS & GYR HVAC CONTROL	880106	PO	SO	01/91
10	CHANGED DWG SHEET COUNT FROM 1 OF 1 TO 1 OF 8.	880105	PO	BK	06/91
11	REVISED DRAWING PER AS-BUILT, ADDED PANEL B, C.D.F. DIST SW. BD., MAIN SW. BD. & NOTE 2	880106	PO	CE	07/91



Notes:

Areas highlighted in yellow indicate space allocated 100% to UW:

No.	Room Description
1	DC Power Room
2	Battery Room
3	Shop
4	Small Parts Storage
5	Main Storage

Area highlighted in purple indicate space allocated 80% to UW and 20% to Tillamook Lightwave, IGA:

No.	Room Description
1	Main Equipment Room

Areas highlighted in blue indicate space allocated 50% to UW and 50% to Tillamook Lightwave, IGA:

No.	Room Description
1	HVAC
2	Break Room
3	Telephone Equipment
4	Entry / Foyer
5	Janitor / Cable Vault
6	Office

The following areas are not identified on the Floor Plan but are allocated as follows:

No.	Room Description
1	Generator Room (50% UW / 50% Tillamook Lightwave, IGA)
2	Storage (100% Tillamook Lightwave, IGA)

Pacific Telecom Cable

FLOOR PLAN

NAME	DATE
DESIGNER G. EKBERG	05/89
DRAWN BY R. CARLASCIO	07/89
PROJ. ENGINEER C. RIDDLE	07/89
CHECKED	
APPROVED C. RIDDLE	07/89
APPROVED	

PACIFIC CITY OREGON

REVISION 11 | DWG SIZE D | DRAWING NO. 63701-11-11

SCALE 1/4"=1'-0" | CAD FILE NO. 63701-02 | SHEET 1 OF 8

REV. 11 | SHEET 1 OF 8 | DRAWING NO. 63701-11-11

17309011 CAD X-REF

Colocation and Lease Agreement

Exhibit B

APPENDIX 1

Flow Down Provisions

1. Equal Employment Opportunity – Lessor shall as appropriate comply with E.O. 11246, "Equal Employment Opportunity," as amended by E.O. 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and as supplemented by regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

2. Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S.C. 276c) – Lessor shall comply with the Copeland "Anti-Kickback" Act (18 U.S.C. 874), as supplemented by Department of Labor regulations (29 CFR part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor or subrecipient shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work to give up any part of the compensation to which he is otherwise entitled. All suspected or reported violations shall be reported to the Federal awarding agency.

3. Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333) – Lessor shall comply with Sections 102 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333), as supplemented by Department of Labor regulations (29 CFR part 5). Under Section 102 of the Act, each contractor shall be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than 1½ times the basic rate of pay for all hours worked in excess of 40 hours in the work week. Section 107 of the Act is applicable to construction work and provides that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

4. Rights to Inventions Made Under a Contract or Agreement – Federal Government and the University of Washington shall have the right to any resulting invention in accordance with 37 CFR part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by NSF.

5. Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.), as amended – Lessor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251 et seq.). Violations shall be reported to NSF, COL and the Regional Office of the Environmental Protection Agency (EPA).

6. Byrd Anti-Lobbying Amendment (31 U.S.C. 1352) – Lessor shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence

an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to COL and NSF.

7. Debarment and Suspension (E.O.s 12549 and 12689) – No contract shall be made to parties listed on the General Services Administration's List of Parties Excluded from Federal Procurement or Nonprocurement Programs in accordance with E.O.s 12549 and 12689, "Debarment and Suspension." This list contains the names of parties debarred, suspended, or otherwise excluded by agencies, and contractors declared ineligible under statutory or regulatory authority other than E.O. 12549. Lessor shall provide certification regarding its exclusion status and that of its principal employees.

8. As required by Section H.11 of the agreement between COL and the University of Washington, during the course of performance of this Lease , COL (and authorized government representatives) shall have the right, at all reasonable times, to make site visits to inspect or review the progress of work or the management control systems of Lessor. Lessor shall provide, at no cost to COL, all reasonable facilities and assistance for the safety and convenience of such representatives in the performance of their duties. Such access shall include the right to inspect Lessor's financial accounts or records that pertain to this Lease.

9. Lessor will acknowledge NSF support in accordance with NSF flow down clause entitled "publications" found at http://www.nsf.gov/pubs/manuals/gpm05_131/gpm7.jsp#740, and sponsorship of the NSF in the Ocean Observatories Initiative ("OOI") project shall be set forth on any signs identifying the Project locations. The National Science Foundation emblem and name shall be prominently displayed on Project facilities and equipment. The emblem and name shall be one inch or larger in size than those of any non-NSF support source.

10. As required by Section H.2.3 of the agreement between COL and the University of Washington, Lessor shall take such action as is necessary to ensure compliance with Section H.2.2 of such agreement which provides as follows:

> H.2.2 – Rights in Data Necessary for the Procurement, Operation and Management of the OOI
>
> 1. Notwithstanding NSF CA-FATC Article 19, Copyrightable Material, or any other clause of this agreement, the Subrecipient grants to Ocean Leadership and the NSF in perpetuity the right to use and reproduce data first produced under this Subaward without charge or additional expense (except for whatever reasonable costs are incurred by Subrecipient to reproduce the data) as necessary for the design, fabrication, integration, installation, operation and management of the OOI. This includes the right to make such data available to any party interested in competing for any subsequent award to operate and manage the OOI, and any awardees the NSF selects as a result of these competitions.

2. The types and kinds of data deemed necessary for the design, fabrication, integration, installation, operation and management of the OOI includes, but is not limited to:

a. Maintenance guides and histories

b. Operating manuals and similar plans

c. User manuals and similar documents

d. Facility and instrument drawings (including design, shop and as-built drawings), designs and specifications

e. Schematics

f. Warranty data

g. Schedules

h. Software

i. Inventories

j. Document indexes

k. Subawards, Lower Tier Awards, and vendor agreements (these items will be assessed by Ocean Leadership and the Subrecipient for the presence of any proprietary data prior to their release to a third party)

l. Operations reports

11. As required by Section H.13 of the agreement between COL and the University of Washington, if the Lessor has knowledge that any actual or potential labor dispute is delaying or threatens to delay the timely performance of this Lease, Lessor shall immediately give notice, including all relevant information, to the University of Washington. All of Lessor's subcontracts shall provide that in the event a contractor's timely performance is delayed or threatened by delay by any actual or potential labor dispute, the lower tier contractor shall immediately notify the next higher tier contractor of all relevant information concerning the dispute.

12. As required by Section H.18.2 of the agreement between COL and the University of Washington, Lessor recognizes that COL may direct the assignment of this Lease to other organizations. Lessor agrees to use its best efforts to effect an orderly and efficient transition from Lessee to any assignee in the event of any such assignment. Lessee will provide Lessor with reasonable advance notice of any such transition in accordance with the notice provisions of Section 30 of the Lease.

13. The Parties acknowledge that the American Reinvestment and Recovery Act requires that certain agreements funded under that Act are required to contain Davis Bacon Act (DBA) wage

determinations for hourly laborers and mechanics performing construction work, in accordance with the rules and procedures of the Department of Labor.

It is anticipated that given the nature of this Lease, any construction-related work will be only incidental to the overall requirements of this Lease. Lessor and any of Lessor's contractors and subcontractors nevertheless must agree that they will, regarding any construction work that is substantial and segregable from the main work of this project, apply DBA requirements to such work, and will at that time submit relevant data to the University of Washington and request an appropriate wage determination. *See*, 48 C.F.R. 22.402, Applicability.

For purposes of this clause and all matters relating to DBA requirements, DBA-related terms shall have the meanings assigned to them by the Department of Labor.

RIGHT OF ENTRY AND LICENSE AGREEMENT

THIS RIGHT OF ENTRY AND LICENSE AGREEMENT ("**Agreement**") is made this 11th day of February, 2011 by and between **THE BOARD OF REGENTS OF THE UNIVERSITY OF WASHINGTON**, a state institution of higher education and an agency of the State of Washington, whose address is Campus Box 359446, 4333 Brooklyn Avenue NE, Seattle, WA 98195-9446 ("**University**"), and **PORTLAND NAP**, a Washington corporation, whose address is 921 SW Washington, Suite 100, Portland OR 97205 ("**Licensor**").

WITNESSETH:

WHEREAS, University is planning to provide or utilize communication services in and to the **Pittock Block Building** located at **921 SW Washington, Portland, OR 97205** (the "**Premises**") and Licensor desires to grant a non-exclusive license in and to the License Area (as defined below).

WHEREAS, the Licensor is the record owner in fee of the Premises and has the unrestricted right to grant the license hereinafter described relative to said property.

NOW, THEREFORE, in consideration of the mutual promises and covenants contained herein, University and Licensor agree as follows:

1. **License**. Licensor hereby grants to University a non-exclusive license including the right of entry (the "**License**") to install, operate, maintain, repair and replace (together the "**Work**") communications cable, and equipment in its License Area (the "**Facilities**") for purposes of providing communications services ("**Services**").

   A. Licensor shall provide for University's use approximately **225 square feet** of caged floor area in **Suite T-275 ("License Area")** as set forth in **Exhibit A** attached hereto.

   B. Licensor shall provide tie cables and cross connects from University's cabinet to Licensor's central network interconnection point within the Building. Licensor shall make cross connects as requested by University. University shall send e-mail request for each cross connect service to bechtell@pittock.com ("**Service Order**"). University shall pay Licensor for each cross connection in accordance with **Exhibit B**, Pittock Block Standard Cross Connect Schedule attached hereto and made a part of this Agreement. All start or stop Service Order requests must be e-mailed in advance of the requested start or stop date.

2. **Initial Term**. The initial term of this Agreement shall commence on the signature date of this Agreement by both Parties ("**Commencement Date**"), and terminate on December 31, 2015 ("**Initial Term Expiration Date**").

3. **Renewal Options**. Provided no Event of Default has occurred, University shall also have an option to extend the Agreement for five (5) additional terms of five (5) years each (each a "**Renewal Option**," and if exercised, each an "**Extension Term**"). All terms of this Agreement shall remain exactly the same during any Extension Term, except the Monthly Payment. University shall exercise its option for the first Extension Term by giving written notice to Licensor, in accordance with the notice requirements of Section 13, not less than ninety (90) days prior to the Initial Term Expiration Date, or, with respect to the exercise of any subsequent Renewal Option, not less than ninety (90) days prior to any Extension Term Expiration Date. Monthly Payment for each Extension Term will be mutually agreed upon by the Parties.

4. **Payment**. Commencing on the date of signature of this Agreement by both parties, University shall pay to Licensor, without notice or demand and without any set-off or deduction whatsoever, the monthly sum of Five Thousand, Four Hundred Dollars ($5,400.00) (plus any amounts due pursuant to requested Service Orders) which University shall pay in advance on or before the first day of each calendar month of the Term (the "**Monthly Payment**"). If University fails to pay within ten (10) days when the same is due and payable, such unpaid amounts shall bear interest at the rate of eighteen percent (18%) per annum from the date due to the date of payment. When the Agreement commences on a day other than the first day of the month, the charge for that month shall be determined by prorating the monthly payment by the number of days during which the Agreement was active.

5. **Construction Covenants.**

A. University shall:

i. prior to the commencement of any Work, at its sole cost and expense, prepare and deliver to Licensor plans and specifications ("**Plans**") detailing the proposed construction and Work. University shall submit the Plans to Licensor for approval. Licensor shall submit its response regarding the proposed Work within ten (10) days after receipt of the Plans. Licensor shall not unreasonably withhold or delay approval of the Plans;

ii. perform all Work in a safe and workmanlike manner consistent with generally accepted construction standards;

iii. perform all Work in such a way as to minimize, as is reasonably practical, any interference with the operations of the Premises;

iv. obtain, prior to the commencement of any Work, the necessary federal, state and municipal permits, licenses and approvals;

v. not permit any liens to be attached to Licensor or to the Premises

vi. repair any damage to Licensor's property or Premises resulting from or related to University's Work; and

vii. not touch or disturb in any way the equipment, cables and associated hardware belonging to Licensor or other licensees.

B. Licensor shall:

i. provide and install one (1) building standard locking cage in the License Area;

ii. provide building standard air conditioning to the License Area; and

iii. provide and install six 20A/120VAC electrical circuits supported by Licensor's UPS and generator systems.

6. **Performance of Work.** University may contract or subcontract any portion of the Work to be performed pursuant to this Agreement. University shall not be relieved of liability for any of its obligations under this Agreement as a result of subcontracting the Work and all of University's subcontractors shall be subject to the provisions of 5.A above.

7. **Covenants**.

A. University hereby covenants and agrees at its sole cost and expense it shall:

i. keep its License Area in good order, repair and condition throughout the Term and any Renewal Term;

ii. comply with any federal, state and municipal laws, orders, rules and regulations applicable to its Work and occupancy of the Premises; and

iii. except as contemplated herein, not to disrupt, adversely affect or interfere with other providers of similar services in the Premises, or with any occupant's use and enjoyment of their licensed space or the common areas of the Premises, or any of Licensor's other licensees, employees or invitees.

B. Licensor hereby covenants and agrees to provide University access to the Facilities, twenty-four (24) hours a day, seven (7) days a week, three hundred and sixty-five (365) days a year in order to allow University to perform installation, maintenance and repair functions, all in accordance with Licensor's rules and regulations, which Licensor may modify from time to time provided such modifications are provided to University in advance in writing.

8. **Equipment and Facilities**. Upon the expiration of this Agreement, University shall, at its sole cost and expense, remove its Facilities from the License Area. University shall repair any and all damage to the Premises caused by the removal of the Facilities.

9. **Warranties.** Licensor makes no warranties or representations that the License Area or the Premises are suitable for the use contemplated by this Agreement. University has inspected the License Area and the Premises and accepts the same "as is". University agrees that Licensor is under no obligation to perform any of the Work or to provide any materials to prepare the License Area or the Premises for University, except as may be described herein. Further Licensor shall have no liability or responsibility for damage or loss to any of University's equipment as University expressly warrants and represents that University is aware that University is not the sole party provided access to the License Area and that other parties shall be provided access to such area at such times as determined by Licensor.

10. **Default and Termination.** Either party may terminate this Agreement upon written notice to the other party in the event:

(1) either party files or initiates proceedings or has proceedings filed or initiated against it, seeking liquidation, reorganization or other relief (such as the appointment of a trustee, receiver, liquidator, custodian or such other official) under any bankruptcy, insolvency or other similar law, and such petition is not discharged within sixty (60) days of filing; or

(2) either party fails to comply with any provisions of this Agreement ("**Default**"), which Default shall not have been cured within thirty (30) days after receiving written notice specifying such Default from the non-defaulting party.

11. **Subject to Laws.** This Agreement is further subject to all applicable federal, state and local laws, and regulations, rulings and orders of governmental agencies, and the obtaining and continuance of any required approval or authorization of the Federal Communications Commission, or any governmental body.

12. **Indemnification.** University shall defend, indemnify and hold Licensor harmless from and against any and all claims, losses, damages, fines, charges, actions, or other liabilities arising out of the negligent acts of University's employees or agents while acting within the scope of their employment with University relating to University's occupancy, work at or use of the Premises of this License. In the event of any litigation or proceeding brought against Licensor and arising out of the negligent acts of University's employees or agents while acting within the scope of their employment with University and relating to University's occupancy, work at or use of the Premises of this License, University shall, upon notice from Licensor, resist and defend such actions or proceedings in consultation with Licensor through legal counsel reasonably satisfactory to Licensor. For the purposes of this Agreement, the parties agree that the Washington State Attorney General's Office is acceptable and satisfactory counsel.

13. **Limitation of Liability**. University, for itself and its customers utilizing equipment in the License Area, acknowledges that use of the License Area and selection and use of equipment therein are at its and its customers' sole risk and except for losses caused by Licensor's gross negligent acts, Licensor shall have no liability therefor. In addition, except for the gross negligent acts of Licensor or Licensor's agents, employees and contractors, Licensor shall not be liable for any claims arising out of or related to this Agreement, the use by University or its customers of the Facilities, Services or Premises or location of equipment therein, or any lost revenue, lost profits, replacement equipment, loss of technology, rights or services, incidental, special, punitive, indirect or consequential damages, loss of data, or interruption or loss of use of service of any equipment or University business, whether under any theory of contract, tort (including negligence) strict liability or otherwise. In no event shall Licensor's liability hereunder exceed the total of three Monthly Payments as provided under this Agreement.

14. **Notices.** Notification of either party through this Agreement will be sufficient when deposited in the United States mail, first class mail, certified letter or return receipt requested, postage prepaid, or by overnight courier as set forth below:

LICENSOR:

Portland NAP
921 SW Washington, Suite 100
Portland, Oregon 97205

UNIVERSITY:

MAILING ADDRESS:
University of Washington
Real Estate Office
Campus Box 359446
Seattle, Washington 98195-9446

COURIER/DELIVERY ADDRESS
University of Washington
Real Estate Office
4333 Brooklyn Ave NE, T-12
Seattle, Washington 98195-9446

15. **Successors and Assigns.** The benefits and obligations of this Agreement shall inure to the benefit of, and be binding upon, the successors, assignees, heirs and personal representatives of the Licensor and University. Either party hereto shall have the right to assign this Agreement upon first obtaining the written consent of the non-assigning party. The assigning party shall provide to the non-assigning party, prior written notice setting forth the name and address of the assignee under any such assignment. Notwithstanding anything to the contrary contained herein, either party may assign this Agreement without consent to a subsidiary, affiliate or parent company to any entity in which it has a majority interest, or to any entity which succeeds to all or substantially all of its assets whether by merger, sale or otherwise.

16. **Insurance.** University, at its cost, shall maintain commercial general liability insurance or self-insurance, or any combination of arrangements, with a liability limit of $1,000,000 per occurrence and $2,000,000 aggregate, insuring against liability of University and its officers, employees and agents to the extent caused by the performance or failure of performance of duties for University in connection with University's use and occupancy of the Premises.

17. **Force Majeure.** In no event shall a party have any claim against the other party for any failure of performance by such party, if such failure of performance is caused by or the result solely of causes beyond the reasonable control of such other party, including, but not limited to: damage caused by a third party, electrical storms, fire, heavy rain, heavy snow, other acts of God, or other natural catastrophe; laws, orders, rules, regulations, directions or action of governmental authorities or of any civil or military authority, national emergency, or strike, lockout, labor shortage or material shortage.

18. **Governing Law.** The Parties' rights and obligations and all interpretations and performances under this Agreement will be governed by the law of the State of Oregon, and any dispute arising from this Agreement shall be brought solely within the courts of Multnomah County, City of Portland, Oregon.

19. **Severability.** In the event that any one or more of the provisions of this Agreement shall for any reason be held to be invalid or unenforceable, the remaining provisions of this Agreement shall be unimpaired, and shall remain in effect and be binding upon the parties.

20. **Waiver.** The failure of either party to enforce or insist upon compliance with any of the terms or conditions of this Agreement, the waiver of any term or condition of this Agreement, or the granting of an extension of time for performance, shall not constitute the permanent waiver of any term or condition of this Agreement, and this Agreement and each of its provisions shall remain at all times in full force and effect until modified by the parties in writing.

21. **Paragraph Headings.** Paragraph headings as contained herein are provided for convenience and reference only. They in no way restrict or limit the contents or terms of this Agreement.

22. **Amendments.** No subsequent agreement between University and Licensor shall be effective or binding unless made in writing and signed by both of the parties hereto.

23. **Final Agreement.** This Agreement sets forth the entire understanding of the parties and supersedes any and all prior agreements, arrangements or understandings related to the subject matter described herein, and no representation, promise, inducement or statement of intention has been made by either party which is not embodied herein.

[THIS SECTION INTENTIONALLY LEFT BLANK]

24. **Flow Down Provisions.** The Project is funded under a cooperative agreement between Consortium of Ocean Leadership (OL) and the National Science Foundation (NSF). Accordingly, and as required by section G.6.11 of the agreement between COL and the University, certain terms and conditions found in the agreement between COL and the University must and shall apply to this Agreement. The following provisions of NSF Financial/Administrative Terms and Conditions (http://www.nsf.gov/pubs/gc1/cafatc_oct10.pdf) shall apply to this Agreement, Articles 12, 17, 23, 26, 27, 30, 31, 34, 37, 38 and 42. These articles are attached as Appendix 1. In addition, the terms and conditions set forth in Appendix 2, which is attached hereto and incorporated herein by this reference, shall apply to this Agreement.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed by their duly authorized representatives on the day and year first above written.

LICENSOR:

PORTLAND NAP

By: Tom Bechtell

Tom Bechtell
Manager

UNIVERSITY:

THE BOARD OF REGENTS OF THE UNIVERSITY OF WASHINGTON

By: ______

Jeanette Henderson
Director of Real Estate

Approved as to Form:
Karen L. Nyrop
Print Name: Karin L Nyrop
Assistant Attorney General
State of Washington

ACKNOWLEDGMENTS

STATE OF WASHINGTON)
COUNTY OF KING)

On this 11th day of February, 2011, before me personally appeared Jeanette L. Henderson, to me known as the Director of Real Estate of the Real Estate Office of the University of Washington, who on oath stated that she was authorized to execute this instrument and acknowledged it to be the free and voluntary act and deed of said University of Washington as approved by **THE BOARD OF REGENTS OF THE UNIVERSITY OF WASHINGTON**, a state institution of higher education and an agency of the state of Washington, for the uses and purposes mentioned in the instrument.

Signature: ______________________
Printed Name: Carol J. Haire
Notary Public in and for the State of Washington
Residing at: Edmonds
My Commission expires on: 3-10-2011

CAROL J. HAIRE
COMMISSION EXPIRES
NOTARY
PUBLIC
MARCH 10, 2011 2014
STATE OF WASHINGTON

STATE OF Oregon)
) ss
COUNTY OF Multnomah)

I certify that I know or have satisfactory evidence that Tom Bechtell (is/are) the person(s) who appeared before me, and said person(s) acknowledged that (he/she/they) signed this instrument, on oath that (he/she/they) (is/are) authorized to execute the instrument and acknowledged it as the Manager of Portland NAI to be the free and voluntary act of such party(ies) for the uses and purposes mentioned in this instrument.

Dated: 2/14/11

Signature: Julia A Spilker
Notary Public in and for the State of: Oregon
Residing in: Portland
My appointment expires: 12/20/14

OFFICIAL SEAL
JULIA A SPILKER
NOTARY PUBLIC - OREGON
COMMISSION NO. 453125
MY COMMISSION EXPIRES DECEMBER 20, 2014

EXHIBIT A - LICENSE AREA

Suite T-275

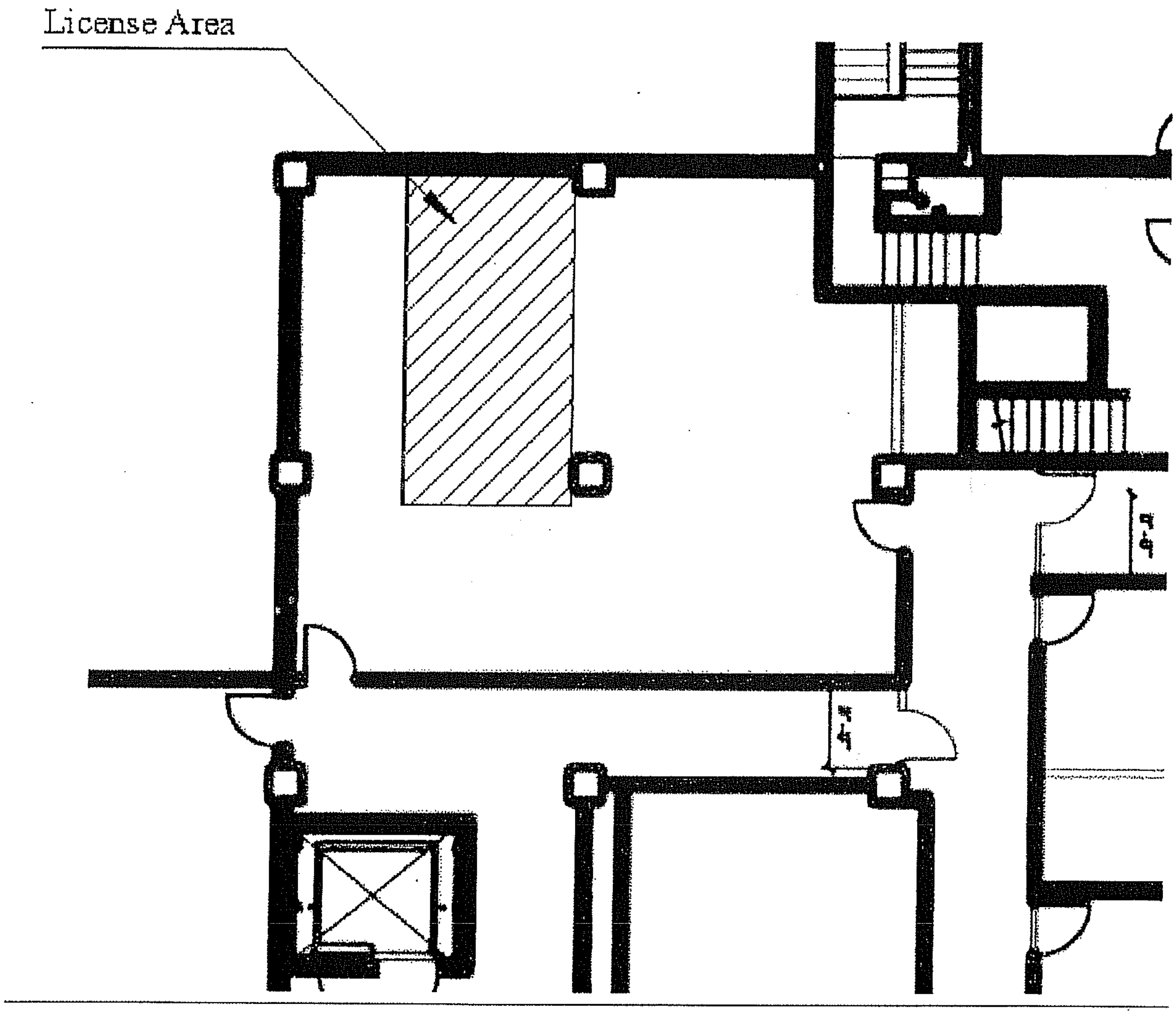


EXHIBIT B - PITTOCK BLOCK
STANDARD CROSS CONNECT SCHEDULE

From License Area to T-250

CROSS CONNECT TERMINATION SPECIFICATIONS

- POTS – terminated into a RJ11 button jack using USOC configuration
- LADS – terminated into an RJ11 jack using USOC configuration
- 10/100BaseTX – terminated into a T568A jack. Twisted pair copper is used for distances up to 300 feet Fiber should be used for distances over 300 feet
- DS1 – terminated into an RJ48X jack
- DS3 – terminated into a BNC jack
- FIBER – multimode and single mode fiber are terminated into a Duplex SC port

Location of terminations within customer cabinet is as determined by Portland NAP installer unless customer specifies a location upon execution of Service Order.

COST PER CROSS CONNECT:

CIRCUIT TYPE	NRC	MRC
TWISTED PAIR	$250.00	$15.00
COAX	$250.00	$50.00
FIBER	$250.00	$100.00

NRC is a one-time non-recurring installation cost due when the Service Order is placed. MRC is a monthly recurring cost due on the first day of each month.

APPENDIX 1 - Applicable NSF Flow Down Provisions

NSF Cooperative Agreement Financial & Administrative Terms and Conditions (CA-FATC)
Effective October 1, 2010

12. Allowable Costs

a. The allowability of costs and cost allocation methods for work performed under this award, up to the amount specified in the award, shall be determined in accordance with the applicable Federal cost principles in effect on the effective date of the award and the terms and conditions of the award.

b. The Federal cost principles applicable to specific types of awardees are contained in:

(i) 2 CFR Part 220, Cost Principles for Educational Institutions (OMB Circular A-21);

(ii) 2 CFR Part 225, Cost Principles for State, Local, and Indian Tribal Governments (OMB Circular A-87);

(iii) 2 CFR Part 230, Cost Principles for Nonprofit Organizations (OMB Circular A-22);

(iv) Federal Acquisition Regulation 31.2 (48 CFR § 31.2) for commercial firms and those non-profit organizations specifically exempted from the provisions of OMB Circular A-122; and

(v) 45 CFR Part 74, Appendix E, "*Principles for Determining Costs Applicable to Research and Development Under Grants and Contracts with Hospitals*," for hospitals.

c. Certain prior approval requirements contained in these Federal cost principles have been modified by Article 3.

17. Information Collection.

Information collection activities performed under this award are the responsibility of the awardee, and NSF support of the project does not constitute NSF approval of the survey design, questionnaire content or information collection procedures. The awardee shall not represent to respondents that such information is being collected for or in association with the National Science Foundation or any other Government agency without the specific written approval of such information collection plan or device by the Foundation. This requirement, however, is not intended to preclude mention of NSF support of the project in response to an inquiry or acknowledgment of such support in any publication of this information.

23. Publications

a. *Acknowledgment of Support.* The awardee is responsible for assuring that an acknowledgment of NSF support:

1. is made in any publication (including World Wide Web sites) of any material based on or developed under this project, in the following terms:

   "This material is based upon work supported by the National
   Science Foundation under Grant No. (NSF grant number)."

2. is orally acknowledged during all news media interviews, including popular media such as radio, television and news magazines.

b. *News. Releases.* The awardee is strongly encouraged to consult with and notify the NSF Program Officer or his/her designee prior to issuing news releases concerning NSF-supported activities.

c. *Disclaimer.* The awardee is responsible for assuring that every publication of material (including World Wide Web pages) based on or developed under this award, except scientific articles or papers appearing in scientific, technical or professional journals, contains the following disclaimer:

> "Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation."

d. *Copies for NSF.* The awardee is responsible for assuring that the cognizant NSF Program Officer is provided access to, either electronically or in paper form, a copy of every publication of material based on or developed under this award, clearly labeled with the award number and other appropriate identifying information, promptly after publication.

e. *Metric System.* All reports and publications resulting from this NSF award are encouraged to use the metric system of weights and measures.

26. Audit and Records.

a. Financial records, supporting documents, statistical records, and other records pertinent to this award shall be retained by the awardee for a period of three years from submission of the final project and expenditure reports specified in Articles 15 and 16.

1. Records that relate to audits, appeals, litigation or the settlement of claims arising out of the performance of the project shall be retained until such audits, appeals, litigation or claims have been disposed of.

2. Records relating to projects subject to special project income provisions shall be retained until three years from the end of the awardee's fiscal year in which the award requirement for reporting income expires.

b. Unless court action or audit proceedings have been initiated, the awardee may substitute microfilm copies of original records.

c. The Director of the National Science Foundation and the Comptroller General of the U.S., or any of their duly authorized representatives, shall have access to any pertinent books, documents, papers and records of the awardee organization and of the performing organization, if different, to make audits, examinations, excerpts and transcripts. Further, any negotiated contract in excess of the simplified acquisition threshold (currently $100,000) made by the awardee shall include a provision to the effect that the awardee, the Director of the National Science Foundation, the Comptroller General of the U.S., or any of their duly authorized representatives, shall have access to pertinent records for similar purposes.

d. In order to avoid duplicate record keeping, NSF may make special arrangements with the awardee to retain any records that are needed for joint use. NSF may request transfer to its custody of records not needed by the awardee when it determines that the records possess long-term retention value. When the records are transferred to, or maintained by NSF, the three-year retention requirement is not applicable to the awardee. In the rare event that this provision is exercised, NSF will negotiate a mutually agreeable arrangement with the awardee regarding reimbursement of costs.

e. Awardees that are States, Local Governments or Non-Profit Organizations, shall arrange for the conduct of audits as required by OMB Circular A-133 "*Audits of States, Local Governments, and Non-Profit Organizations*" (including colleges and universities.) They shall provide copies of the reports of these audits to the cognizant Federal audit agency. Any Federal Audit of this project deemed necessary by NSF shall build upon the results of such audit(s).

27. Site Visits. NSF, through authorized representatives, has the right, at all reasonable times, to make site visits to review project accomplishments and management control systems and to provide such technical assistance as may be required. If any site visit is made by NSF on the premises of the awardee or a contractor under an award, the awardee shall provide and shall require its contractors to provide all reasonable facilities and assistance for the safety and convenience of the Government representatives in the performance of their duties. All site visits and evaluations shall be performed in such a manner that will not unduly delay the work.

30. Nondiscrimination.

a. The award is subject to the provisions of Title VI of the Civil Rights Act of 1964 [42 U.S.C. § 2000d], Title IX of the Education Amendments of 1972 [20 USC §§ 1681 *et seq.*], the Rehabilitation Act of 1973 [29 U.S.C. § 794], the Age Discrimination Act of 1975 [42 U.S.C. §§ 6101 et seq], and all regulations and policies issued by NSF pursuant to these statutes. Specifically, in accordance with these statutes, regulations, and policies, no person on the basis of race, color, national origin, sex, disability, or age shall be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under the award.

b. By electronically signing a proposal, the Authorized Organizational Representative is providing the requisite Certification of Compliance with National Science Foundation Nondiscrimination Regulations and Policies. This Nondiscrimination Certification sets forth the nondiscrimination obligations with which all awardees must comply.5 These obligations also apply to subrecipients, subawardees, and subcontractors under the award. The awardee, therefore, shall obtain the NSF Nondiscrimination Certification from each organization that applies to be or serves as a subrecipient, subgrantee or subcontractor under the award (for other than the provision of commercially available supplies, materials, equipment or general support services) prior to entering into the subaward arrangement.

31. Reporting Classifiable Information. NSF awards are intended for unclassified, publicly releasable research. The awardee will not be granted access to classified information. NSF does not expect that the results of the research project will involve classified information.

If, however, in conducting the activities supported under an award, the PI is concerned that any of the research results involve potentially classifiable information that may warrant Government restrictions on the dissemination of the results, the PI should promptly notify the cognizant NSF Program Officer.

34. Clean Air and Water.

(Applicable only if the award exceeds $100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act [42 U.S.C. § 7413(c)(1)] or the Clean Water Act [33 U.S.C. § 1319(c)] and is listed by the Environmental Protection Agency (EPA), or the award is not otherwise exempt.)

The awardee agrees as follows:
a. To comply with all the requirements of Section 114 of the Clean Air Act [42 U.S.C. § 7414] and Section 308 of the Clean Water Act [33 U.S.C. § 1318], respectively, relating to inspection, monitoring, entry, reports and information, as well as other requirements specified in Section 114 and Section 308 of the Clean Air Act and the Clean Water Act, respectively, and all regulations and guidelines issued thereunder before the award of the cooperative agreement.

b. That no portion of the work required by the award will be performed in a facility listed on the Environmental Protection Agency List of Violating Facilities on the date that the award was awarded unless and until EPA eliminates the name of such facility or facilities from such listing.

c. To use its best efforts to comply with clean air standards and clean water standards at the facility in which the award is being performed.

d. To insert the substance of the provisions of this article into any nonexempt subcontract.

37. State Sales and Use Taxes. Awardees are reminded that each set of cost principles cited in Article 12b limits the allowability of taxes to those the organization is required to pay. Awardees must avail themselves of any tax exemptions for which any activities supported by Federal funds may qualify, including any applicable exemptions from state or local sales and use taxes on the purchase of goods and services made with NSF award funds.

38. Debarment and Suspension. Recipients shall fully comply with the requirements stipulated in Subpart C of 45 CFR Part 620, entitled "*Responsibilities of Participants Regarding Transactions.*" The recipient is responsible for ensuring that any lower tier covered transaction, as described in Subpart B of 45 CFR Part 620, entitled "*Covered Transactions*," includes a term or condition requiring compliance with Subpart C. The recipient also is responsible for further requiring the inclusion of a similar term or condition in any subsequent lower tier covered transaction. The recipient acknowledges that failing to disclose the information required under 45 CFR § 620.335 may result in the termination of the award, or pursuance of other available remedies, including suspension and debarment. Recipients may access the Excluded Parties List System at http://epls.arnet.gov.

OTHER CONSIDERATIONS

42. Liability. NSF cannot assume any liability for accidents, illnesses, injuries, or claims arising out of, or related to, any activities supported by an award or for unauthorized use of patented or copyrighted materials. The awardee organization is advised to take such steps as may be deemed necessary to insure or protect itself, its employees and its property.

APPENDIX 2
Flow Down Provisions

1. Equal Employment Opportunity – Licensor shall as appropriate comply with E.O. 11246, "Equal Employment Opportunity," as amended by E.O. 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and as supplemented by regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

2. Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S.C. 276c) – Licensor shall comply with the Copeland "Anti-Kickback" Act (18 U.S.C. 874), as supplemented by Department of Labor regulations (29 CFR part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor or subrecipient shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work to give up any part of the compensation to which he is otherwise entitled. All suspected or reported violations shall be reported to the Federal awarding agency.

3. Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333) – Licensor shall comply with Sections 102 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333), as supplemented by Department of Labor regulations (29 CFR part 5). Under Section 102 of the Act, each contractor shall be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than 1½ times the basic rate of pay for all hours worked in excess of 40 hours in the work week. Section 107 of the Act is applicable to construction work and provides that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

4. Rights to Inventions Made Under a Contract or Agreement – Federal Government and the University shall have the right to any resulting invention in accordance with 37 CFR part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by NSF.

5. Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.), as amended – Licensor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251 et seq.). Violations shall be reported to NSF, COL and the Regional Office of the Environmental Protection Agency (EPA).

6. Byrd Anti-Lobbying Amendment (31 U.S.C. 1352) – Licensor shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to COL and NSF.

7. Debarment and Suspension (E.O.s 12549 and 12689) – No contract shall be made to parties listed on the General Services Administration's List of Parties Excluded from Federal Procurement or Nonprocurement Programs in accordance with E.O.s 12549 and 12689, "Debarment and Suspension." This list contains the names of parties debarred, suspended, or otherwise excluded by agencies, and contractors declared ineligible under statutory or regulatory authority other than E.O. 12549. Licensor shall provide certification regarding its exclusion status and that of its principal employees.

8. As required by Section H.11 of the agreement between COL and the University, during the course of performance of this Agreement, COL (and authorized government representatives) shall have the right, at all reasonable times, to make site visits to inspect or review the progress of work or the management control systems of Licensor. Licensor shall provide, at no cost to COL, all reasonable facilities and assistance for the safety and convenience of such representatives in the performance of their duties. Such access shall include the right to inspect Licensor's financial accounts or records that pertain to this Agreement.

9. Licensor will acknowledge NSF support in accordance with NSF flow down clause entitled "publications" found at http://www.nsf.gov/pubs/manuals/gpm05_131/gpm7.jsp#740, and sponsorship of the NSF in the Ocean Observatories Initiative ("OOI") project shall be set forth on any signs identifying the Project locations. The National Science Foundation emblem and name shall be prominently displayed on Project facilities and equipment. The emblem and name shall be one inch or larger in size than those of any non-NSF support source.

10. As required by Section H.2.3 of the agreement between COL and the University, Licensor shall take such action as is necessary to ensure compliance with Section H.2.2 of such agreement which provides as follows:

H.2.2 – Rights in Data Necessary for the Procurement, Operation and Management of the OOI

1. Notwithstanding NSF CA-FATC Article 19, Copyrightable Material, or any other clause of this agreement, the Subrecipient grants to Ocean Leadership and the NSF in perpetuity the right to use and reproduce data first produced under this Subaward without charge or additional expense (except for whatever reasonable costs are incurred by Subrecipient to reproduce the data) as necessary for the design, fabrication, integration, installation, operation and management of the OOI. This includes the right to make such data available to any party interested in competing for any subsequent award to operate and manage the OOI, and any awardees the NSF selects as a result of these competitions.

2. The types and kinds of data deemed necessary for the design, fabrication, integration, installation, operation and management of the OOI includes, but is not limited to:

a. Maintenance guides and histories

b. Operating manuals and similar plans
c. User manuals and similar documents
d. Facility and instrument drawings (including design, shop and as-built drawings), designs and specifications
e. Schematics
f. Warranty data
g. Schedules
h. Software
i. Inventories

j. Document indexes

k. Subawards, Lower Tier Awards, and vendor agreements (these items will be assessed by Ocean Leadership and the Subrecipient for the presence of any proprietary data prior to their reAgreement to a third party)

l. Operations reports

11. As required by Section H.13 of the agreement between COL and the University, if the Licensor has knowledge that any actual or potential labor dispute is delaying or threatens to delay the timely performance of this Agreement, Licensor shall immediately give notice, including all relevant information, to the University. All of Licensor's subcontracts shall provide that in the event a contractor's timely performance is delayed or threatened by delay by any actual or potential labor dispute, the lower tier contractor shall immediately notify the next higher tier contractor of all relevant information concerning the dispute.

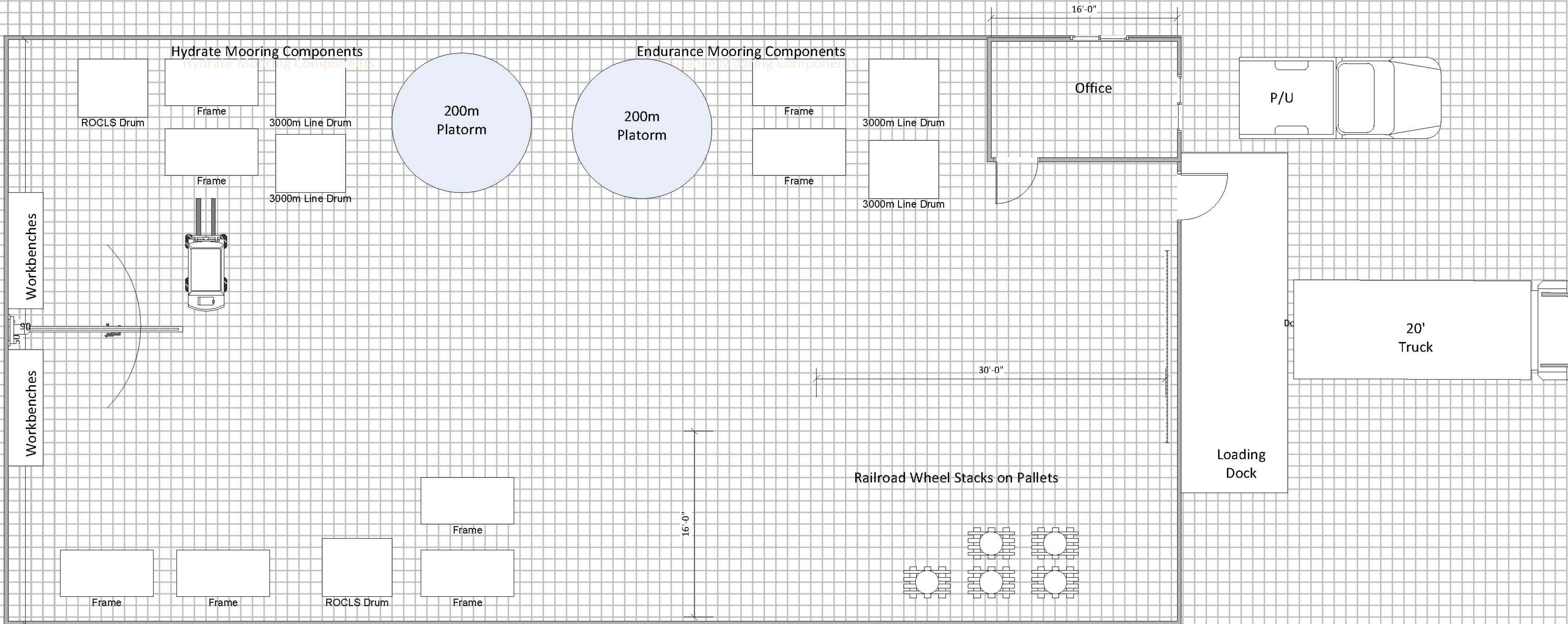
12. As required by Section H.18.2 of the agreement between COL and the University, Licensor recognizes that COL may direct the assignment of this Agreement to other organizations. Licensor agrees to use its best efforts to effect an orderly and efficient transition from University to any assignee in the event of any such assignment. University will provide Licensor with reasonable advance notice of any such transition in accordance with the notice provisions of Section of the Agreement.

13. The Parties acknowledge that the American Reinvestment and Recovery Act requires that certain agreements funded under that Act are required to contain Davis Bacon Act (DBA) wage determinations for hourly laborers and mechanics performing construction work, in accordance with the rules and procedures of the Department of Labor.

It is anticipated that given the nature of this Agreement, any construction-related work will be only incidental to the overall requirements of this Agreement. Licensor and any of Licensor's contractors and subcontractors nevertheless must agree that they will, regarding any construction work that is substantial and segregable from the main work of this project, apply DBA requirements to such work, and will at that time submit relevant data to the University and request an appropriate wage determination. See, 48 C.F.R. 22.402, Applicability.

For purposes of this clause and all matters relating to DBA requirements, DBA-related terms shall have the meanings assigned to them by the Department of Labor.

Notional Layout for Space of Oregon Depot 50'x100' Building

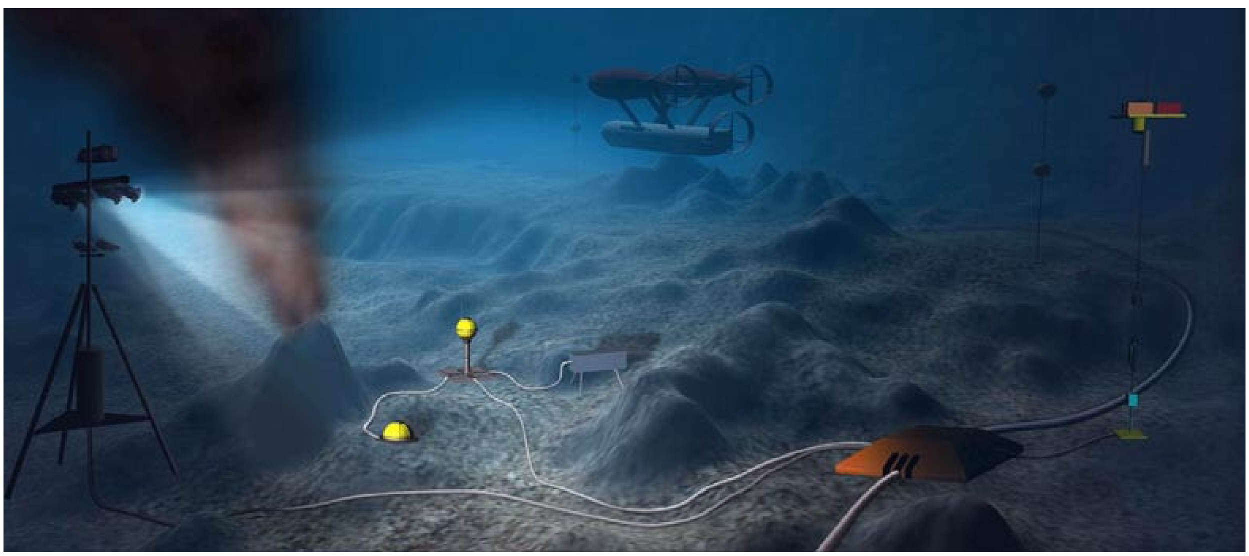


Need to add;

- Secure area for storage of RSN ATTN items (Asset Tracked)
- Bathroom/s (option)
- Sink (water source for any testing?)
- Entry Rollup door min 15ft w x 15ft tall.
- Floor/loading dock load limit ~150lb sq ft. (Important)

Regional Scale Nodes Operations and Maintenance Primary Infrastructure Basis of Estimate

Version 1-00



Prepared by
University of Washington for the
Ocean Observatories Initiative
May 5, 2011

Document Number 4140-65982

Document Control Sheet

Version	Release Date	Description	By
1-00		Initial Version	B. Ittig

Table of Contents

1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). This document contains the Basis of Estimate for the Primary Infrastructure required during the Operation and Maintenance phase of the program including costs associated with wet plant maintenance costs,

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name	WBS Definition
2.4.1.2.6	C	Primary Infrastructure - 2011	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, regulatory permit compliance requirement support, and North America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support for O&M Calendar Year 2 (2011).
2.4.1.2.6.20	W	MATL - Primary Infrastructure - 2011	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.21	W	TRVL - Primary Infrastructure - 2011	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.22	W	SUBS - Primary Infrastructure - 2011	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.23	W	EQUP - Primary Infrastructure - 2011	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit compliance

WBS #	Element Type	Name	WBS Definition
			requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.24	W	Regulatory Compliance - 2011 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 2 (2011). A large component of this will be support of the Oregon Fishermen's Cable Committee.
2.4.1.2.6.24	W	Wet Plant Maintenance - 2011 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 2 (2011), highlighted by support of the North America Cable Zone Maintenance Agreement.
2.4.1.2.6.25	W	Wet Plant Spares - 2011 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure spare for O&M Calendar Year 2 (2011).

Note: Above Control Accounts/Work Packages are for Calendar Year 2. Similar Control Accounts/Work Packages created for each Calendar Year – associated WBS number is identical to the above structure except for the fourth digit, which is modified to represent the Calendar Year.

2.2. Task Description

The tasks involved in calendar years 2011 through 2014 includes costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, regulatory permit compliance requirement support, and North America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support.

2.3. Estimation Technique

Submarine Cable Depot – Pacific City, Oregon
Estimation Technique: Vendor Quote (verbal)

A cable depot is a facility that will provide long-term storage of the primary infrastructure spares, including submarine cable and repeaters, and will consist of cable tanks and repeater area. The depot will be required to have ship berthing capabilities for access to the submarine plant for any required repairs to the network.

The cable depot in Portland charges by volume (m^3) occupied per year. The cubic meter fee per year is $1,000 and repeater storage is $320 / unit.

For SL-17 cable, approximately 0.94km of Special Purpose Armor (SPA) cable; and 0.877km of Light Wire Armor (LWA) cable per $1m^3$.

Contractual spare submarine cable is:

- SPA Cable: 13.8 km = 14.7 m^3
- LWA Cable: 6.8 km = 7.8 m^3

Therefore, cable storage is estimates at approximately $22,500 / year and approximately $1,000 per year for repeater and spare joint kits.

North America Zone Maintenance Agreement = $250k / year (Ocean Leadership budget)

Labor / Travel:
Engineering Estimates: Estimates based on known resources rates and Implementing Organizations' understanding of the project scope as it relates to engineering support requirements and commercial undersea cable construction projects. Estimates are based on experience of estimators with over 50 years of experience in performing similar activities on submarine cable networks.

3. Budgeted Unit Quantities

Unit	2011	2012	2013	2014	2015
Subcontracts • Cable Depot (Portland, OR)	8 months	12 months	12 months	12 months	12 months
Labor	300 hours	300 hours	300 hours	400 hours	400 hours

Unit quantities are based on full year facility occupation. Each of the unit cost for the items in this BOE are captured below.

4. Unit Cost Estimates

4.1. Task Descriptions (CY2, 2011)

Travel

Portland Cable Depot: Engineers will be required to travel semi-annually to the Portland Cable Depot to inventory and verify the Primary Infrastructure wet plant spares including the submarine cable and repeaters; maintenance, and equipment inspection and maintenance.
Meeting Support: Regulatory Permit Compliance, Oregon Fisherman's Cable Committee and NAZ Cable Maintenance Agreement meeting participation and support.

Required travel is estimated at three (3) trips / year = 3 Total Domestic Trips.

Subcontracts – Lease payment to the Portland Cable Depot is planned to be annually.

Labor –Field Engineers will be responsible to inventory the Primary Infrastructure wet plant spares, and Marine Operations/Maintenance Manager will support regulatory permit compliance requirements (meetings); and the North America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee meetings. Labor is estimated at 300 hours per year to support the above activities.

4.2. Resource Estimates (CY2, 2011)

Travel

Total: (Primary Infrastructure)	**3**
Primary Infrastructure Inventory / Verification	1
Regulatory Permit Compliance Support	1
Oregon Fisherman's Cable Committee	1
NAZ Cable Maintenance Agreement Support	0

Subcontracts

Total: (Primary Infrastructure)	
Primary Infrastructure Spare Storage ($36,000 / year) (Yearly costs are based on the amount of volume the primary infrastructure spares occupy at the cable depot in Portland, OR)	$36,000

Labor

Total: (Primary Infrastructure)	
Marine Operation/Maintenance Manager (300 hours / year)	0.15 FTE

4.3. Task Descriptions (CY3, 2012 and CY4, 2013)

Travel

Portland Cable Depot: Engineers will be required to travel semi-annually to the Portland Cable Depot to inventory and verify the Primary Infrastructure wet plant spares including the submarine cable and repeaters; maintenance, and equipment inspection and maintenance.
Meeting Support: Regulatory Permit Compliance, Oregon Fisherman's Cable Committee and NAZ Cable Maintenance Agreement meeting participation and support.

Required travel is estimated at five (5) trips = 5 Total Domestic Trips.

Subcontracts – Lease payment to the Portland Cable Depot is planned to be annually.

Labor –Field Engineers will be responsible to inventory the Primary Infrastructure wet plant spares, and Marine Operations/Maintenance Manager will support regulatory permit compliance requirements (meetings); and the North America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee meetings. Labor is estimated at 300 hours per year to support the above activities.

4.4. Resource Estimates (CY3, 2012 and CY4, 2013)

Travel

Total: (Primary Infrastructure)	**5**
Primary Infrastructure Inventory / Verification	2
Regulatory Permit Compliance Support	1
Oregon Fisherman's Cable Committee	1
NAZ Cable Maintenance Agreement Support	1

Subcontracts

Total: (Primary Infrastructure)	
Primary Infrastructure Spare Storage ($36,000 / year) (Yearly costs are based on the amount of volume the primary infrastructure spares occupy at the cable depot in Portland, OR)	$36,000

Labor

Total: (Primary Infrastructure)	
Marine Operation/Maintenance Manager (300 hours / year)	0.15 FTE

4.5. Task Descriptions (CY5, 2014)

Travel

Portland Cable Depot: Engineers will be required to travel semi-annually to the Portland Cable Depot to inventory and verify the Primary Infrastructure wet plant spares including the submarine cable and repeaters; maintenance, and equipment inspection and maintenance.
Meeting Support: Regulatory Permit Compliance, Oregon Fisherman's Cable Committee and NAZ Cable Maintenance Agreement meeting participation and support.

Required travel is estimated at five (5) trips = 5 Total Domestic Trips.

Subcontracts – Lease payment to the Portland Cable Depot is planned to be annually.

Labor –Field Engineers will be responsible to inventory the Primary Infrastructure wet plant spares, and Marine Operations/Maintenance Manager will support regulatory permit compliance requirements (meetings); and the North America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee meetings. Labor is estimated at 400 hours per year to support the above activities.

4.6. Resource Estimates (CY5, 2014)

Travel

Total: (Primary Infrastructure)	**5**
Primary Infrastructure Inventory / Verification	2
Regulatory Permit Compliance Support	1
Oregon Fisherman's Cable Committee	1
NAZ Cable Maintenance Agreement Support	1

Subcontracts

Total: (Primary Infrastructure)	
Primary Infrastructure Spare Storage ($36,000 / year) (Yearly costs are based on the amount of volume the primary infrastructure spares occupy at the cable depot in Portland, OR)	$36,000

Labor

Total: (Primary Infrastructure)	
Marine Operation/Maintenance Manager (400 hours / year)	0.2 FTE

5. Steady State

5.1. Task Descriptions (Steady State)

Travel

Portland Cable Depot: Engineers will be required to travel semi-annually to the Portland Cable Depot to inventory and verify the Primary Infrastructure wet plant spares including the submarine cable and repeaters; maintenance, and equipment inspection and maintenance.
Meeting Support: Regulatory Permit Compliance, Oregon Fisherman's Cable Committee and NAZ Cable Maintenance Agreement meeting participation and support.

Required travel is estimated at five (5) trips = 5 Total Domestic Trips.

Subcontracts – Lease payment to the Portland Cable Depot is planned to be annually.

Labor –Field Engineers will be responsible to inventory the Primary Infrastructure wet plant spares, and Marine Operations/Maintenance Manager will support regulatory permit compliance requirements (meetings); and the North America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee meetings. Labor is estimated at 400 hours per year to support the above activities.

5.2. Resource Estimates (CY5, 2014)

Travel

Total: (Primary Infrastructure)	**5**
Primary Infrastructure Inventory / Verification	2
Regulatory Permit Compliance Support	1
Oregon Fisherman's Cable Committee	1
NAZ Cable Maintenance Agreement Support	1

Subcontracts

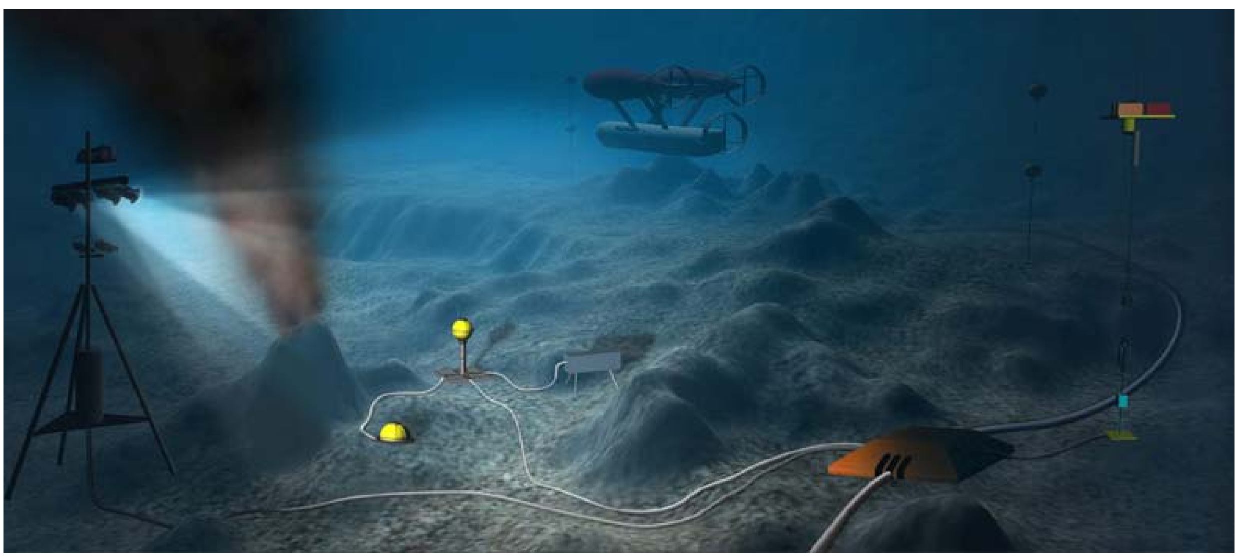
Total: (Primary Infrastructure)	
Primary Infrastructure Spare Storage ($36,000 / year) (Yearly costs are based on the amount of volume the primary infrastructure spares occupy at the cable depot in Portland, OR)	$36,000

Labor

Total: (Primary Infrastructure)	
Marine Operation/Maintenance Manager (400 hours / year)	0.2 FTE

Regional Scale Nodes Operations and Maintenance Secondary Infrastructure Instruments Basis of Estimate

Version 1-00



Prepared by
University of Washington for the
Ocean Observatories Initiative
May 5,2011

Document Number 4140-65983

Document Control Sheet

Version	Release Date	Description	By
1-00		Initial Version	M. Harrington

Table of Contents

1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). The document contains the Basis of Estimate for the Operation and Maintenance phase of the program for the Secondary Infrastructure Instruments. This document includes the quantities of Instruments procured or built during the first five years of O&M what will be used for maintaining the Instruments installed in the Baseline configuration, the unit cost justification for the parts and labor to build the Instruments and the justification for the annul recurring maintenance cost once the system is in steady state.

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name
2.4.1.3.7	CA	Secondary Infrastructure - 2012
2.4.1.3.7.21.2	S	EQUIP - Instruments Spares 2012
2.4.1.3.7.23	WP	Instruments Spares 2012
2.4.1.4.7	CA	Secondary Infrastructure - 2013
2.4.1.4.7.21.3	S	EQUIP - Instruments Spares 2013
2.4.1.4.7.24	WP	Instruments Spares 2013
2.4.1.5.7	CA	Secondary Infrastructure - 2014
2.4.1.5.7.21.3	S	EQUIP - Instruments Spares 2014
2.4.1.5.7.24	WP	Instruments Spares 2014
2.4.1.6.7	CA	Secondary Infrastructure - 2015 (Steady State)
2.4.1.6.7.23.1	T	EQUP - Calibration (2015 Spares 2nd Infr)
2.4.1.7.7	CA	Secondary Infrastructure - 2016
2.4.1.7.7.23.1	T	EQUP - Calibration (2015 Spares 2nd Infr)
2.4.1.7.7.23.2	T	EQUP - Instrument Replacement

2.2. Task Description

The tasks involved in calendar years 2012, 2013 and 2014 includes procuring instruments, materials, building and assembling of instruments and testing the built up systems. Sufficient quantities of units will be built to support the annual maintenance replacement strategy as defined in document # *4308-00005_Sensor_Maintenance_Plan_RSN*. It is assumed that all systems will be fully defined during the Subsystem Development phase of the project such that no new engineering or modifications will take place under this work package. The tasks involved during steady state includes refurbishing and calibrating any systems that have been replaced in the field in preparation for the next maintenance cruise and repairing any failed systems or components.

2.3. Estimation Technique

The unit costs for the all the instruments were estimated as part of the MREFC Construction Budget. Those estimates are reused for the O & M with the correction inflation factors applied. The labor estimates are engineering estimates based the complexity of the systems compared to similar platforms built at APL for underwater observatory projects, both cabled and uncabled. The materials were estimated on a line items basis with the supporting quotes supplemental to this BOE. In some cases the quote were from Vendors with existing Instruments that met the requirements, in other cases it was based on documented email correspondence with organizations that could provide the unique instruments needed for RSN.

3. Budgeted Unit Quantities

Resource	2012	2013	2014
UW APL Sensor ADCPS	1		1
UW APL Sensor ADCPT	1		
UW APL Sensor BOTPT	1		
UW APL Sensor CAMDS	3	2	
UW APL Sensor CAMHD	1	1	
UW APL Sensor CTDPF			10
UW APL Sensor DOSTA		5	5
UW APL Sensor FLORD		3	
UW APL Sensor FLORT		5	
UW APL Sensor HPIES		1	
UW APL Sensor HYDBB		1	
UW APL Sensor HYDLF	1		
UW APL Sensor MASSP	1	2	
UW APL Sensor NUTNR		1	2
UW APL Sensor OBSBB	1		
UW APL Sensor OBSSP	2		
UW APL Sensor OPTAA		2	
UW APL Sensor OSMOI		2	2
UW APL Sensor OTISF	1		
UW APL Sensor PARAD		1	2
UW APL Sensor PCO2W			2
UW APL Sensor PHSEN		1	4
UW APL Sensor PPSDN		1	
UW APL Sensor PREST	1		
UW APL Sensor RASFL		1	
UW APL Sensor SPKIR		1	2
UW APL Sensor THSPH		1	1
UW APL Sensor TMPSF	1		
UW APL Sensor TRHPH		1	1
UW APL Sensor VADCP		1	
UW APL Sensor VEL3D	1		

These unit quantities are based on replacement strategies as defined in document # *4308-00005_Sensor_Maintenance_Plan_RSN*. The replacement plan takes into account how many years an instrument is expected to be able to stay deployed before it must be recovered and refurbished. The quantities take into account both the number of sensors needed to support normal exchanges of instruments on the annual cruise but also spare sensor that may be needed in case a unit fails.

4. Unit Cost Estimates

Each of the unit cost for the items in this BOE is listed on the separate spreadsheets listed in 4140-00022_Instrument_BOE_RSN.

RSN Material List Basis of Estimate Sheet - Instrument

Sensor ID	Discription	Estimate	Quote List	Detail
OPTAA	attenuation_absorption_optical	$ 5,800	4120-00056	mfr quote
CAMDS	camera_digital_still_strobe	$ 55,000	4120-00033	mfr quote
CAMHD	camera_digital_video_HD	$ 96,000	4120-00043	mfr quote
CTDPF	CTD_profiler	$ 10,060	4120-00034	mfr quote
PPSDN	DNA_particulate	$ 45,000	4120-00031	mfr quote + alterations +PI quote
OTISF	flow_benthic	$ 100,000	4120-00058	PI quote
FLORT	Fluorometer_three_wavelength	$ 13,905	4120-00049	mfr quote
FLORD	Fluorometer_two_wavelength	$ 4,600	4120-00048	mfr quote
HYDBB	Hydrophone_BB_passive	$ 10,092	4120-00032	mfr quote
HPIES	IES_pressure_velocity	$ 50,000	4120-00050	PI quote
MASSP	mass_spectrometer	$ 65,000	4120-00055	mfr quote
ACOMM	Modem_acoustic	$ 9,188	4120-00054	mfr quote
NUTNR	nutrient_Nitrate	$ 30,990	4120-00039	mfr quote
DOSTA	oxygen_dissolved_stable	$ 1,326	4120-00035	mfr quote
PARAD	PAR	$ 1,125	4120-00037	mfr quote
PCO2W	pCO2_water	$ 19,000	4120-00051	mfr quote
PHSEN	pH	$ 3,995	4120-00036	mfr quote
BOTPT	pressure_bottom_tilt	$ 80,000	4120-00041	mfr quote + alterations
PREST	pressure_SF_tidal	$ 35,000	4120-00042	mfr quote + alterations
OBSBB	Seismometer_BB_triaxial_accel	$ 100,000	4120-00047	PI quote
OBSBK	Seismometer_BB_triaxial_keck	$ 40,000	4120-00047	PI quote + alterations
OBSSP	Seismometer_shortperiod	$ 30,000	4120-00044	PI quote + alterations
OBSSK	Seismometer_shortperiod_keck	$ 5,000	4120-00044	PI quote + alterations
SPKIR	spectral_irradiance	$ 8,455	4120-00038	mfr quote
THSPH	Temp_H2_H2S_pH	$ 20,000	4120-00059	PI quote
TRHPH	Temp_resist	$ 45,000	4120-00061	PI quote
TMPSF	Temperature_seafloor	$ 30,000	4120-00060	PI quote
VEL3D	Velocity_point_3D_turb	$ 14,000	4120-00053	mfr quote
ADCPT	Velocity_profile_300m	$ 38,926	4120-00040	mfr quote
VADCP	Velocity_profile_50m_turb	$ 65,000	4120-00052	mfr quote
ADCPS	Velocity_profile_600m	$ 47,405	4120-00040	mfr quote
OSMOI	watersample_chem_trace	$ 15,000	4120-00057	mfr quote
RASFL	watersample_chem_trace_H2S_pH	$ 70,000	4120-00030	mfr quote + alterations+PI quote
			Notes:	
	Doc Num	**4140-00022**		
	Estimated By			
	Revision	**Ver_2-02**		
	Date	**10/31/2008**		
	Approved By			
	Date			

Each line item is described with a unit cost and a quote to support the estimate. The Sensor ID in an OOI controlled 5 Digit reference that is used across the project and files to distinguish exactly which sensor is being described.

Labor is allocated between procuring the instruments and incoming inspection and and testing of the unit. Again it is assumed that all RFPs are in place and all test procedures, fixtures and equipment were developed as part of the construction phase of the program.

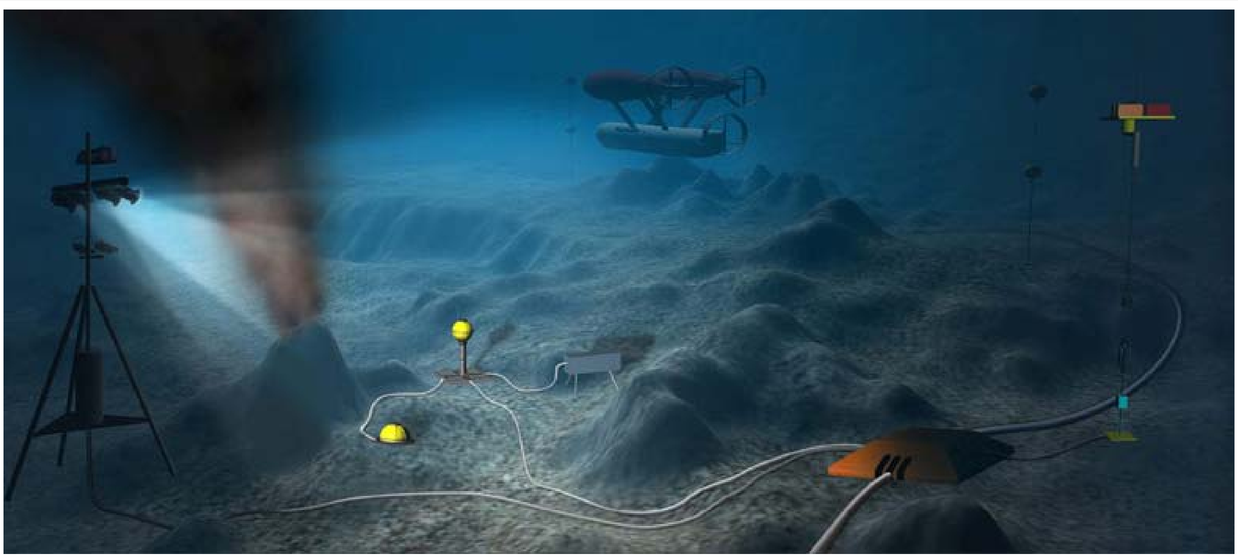
For the procurement of 2 days of an Electrical Engineer 3 was budgeted to issue the PO of an existing contract for each instrument. For incoming inspection and testing 3 days of an Electrical Engineer 3 and one day of a Senior Ocean Engineer was budgeted for each instrument.

5. Steady State

The steady state estimate for Secondary Infrastructure Instruments includes the estimated cost of materials to replace instruments based on their life expectancy, or on the environment that they are placed in. Some instruments will only last a year given they will be placed in extremely hot and or acidic environments. Also encompassed in the steady state budget is anticipated annual cost to calibrate sensors that have been recovered on the annual maintenance cruises.

Regional Scale Nodes Operations and Maintenance Secondary Infrastructure Extension Cables Basis of Estimate

Version 1-00



Prepared by

University of Washington for the

Ocean Observatories Initiative

May 5,2011

Document Number 4140-65984

Document Control Sheet

Version	Release Date	Description	By
1-00		Initial Version	M. Harrington

Table of Contents

1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). The document contains the Basis of Estimate for the Operation and Maintenance phase of the program for the Secondary Infrastructure Extension Cables. This document will include the quantities of components procured during the first five years of O&M that will be used for maintaining the infrastructure installed in the baseline configuration, the unit cost justification for the parts and labor to procure the components.

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name
2.4.1.3.7	CA	Secondary Infrastructure - 2012
2.4.1.3.7.21.3	S	EQUP - Extension Cables - Spares 2012
2.4.1.3.7.24	WP	Extension Cables Spares 2012
2.4.1.4.7	CA	Secondary Infrastructure - 2013
2.4.1.4.7.21.4	S	EQUIP - Extension Cables Spares 2013
2.4.1.4.7.25	WP	Extension Cables Spares 2013
2.4.1.5.7	CA	Secondary Infrastructure - 2014
2.4.1.5.7.21.4	S	EQUP - Extension Cables - Spares 2014
2.4.1.5.7.25	WP	Extension Cables Spares 2014

2.2. Task Description

The tasks involved in calendar years 2012, 2013 and 2014 includes procuring spare components and materials for the installed Extension Cables. Sufficient quantities of units will be built to support the annual maintenance replacement strategy as defined in document # *4314-00001_OM_Secondary_Spares_Plan_RSN*. It is assumed that all systems will be fully defined during the Subsystem Development phase of the project such that no new engineering or modifications will take place under this work package.

2.3. Estimation Technique

The unit costs for the all the Extension Cable Components were estimated as part of the MREFC Construction Budget. Those estimates are reused for the O & M with the correction inflation factors applied. The labor estimates are engineering estimates including the task of defining the documentation package for the equipment to be procured in the calendar year and to issue the appropriate purchase orders. No labor was assigned for assembling or testing as the received components will remain in stock until a repair is necessary. The materials were estimated on a line items basis with the higher dollar items being based on quotes supplied supplemental to this BOE.

3. Budgeted Unit Quantities

Resource	2012	2013	2014
UW APL Cable Armor High Power	5000(m)		
UW APL Cable High Power Seafloor	16000(m)	4865(m)	
UW APL Cable Low Power Sensor		1000	600
UW APL Connector Dry Electrical			40
UW APL Connector ROV Electrical	2	4	10
UW APL Connector ROV Optical	6	4	
UW APL CTA Electrical		4	4
UW APL CTA Optical	6	4	

These unit quantities are based on replacement strategies as defined in document # *4314-00001_OM_Secondary_Spares_Plan_RSN* and *4308-00005_Sensor_Maintenance_Plan_RSN*. These spares will support 18 EO cables longer than 1 km installed in the system and 42 cables less than 1km that have ROV wet mate connectors. Two of the longer cables include buried armored cables one at 18km in length and the other 10km. All components are specified to have a 25 year life time so this is to support damage due to external aggression or handling errors.

4. Unit Cost Estimates

Each of the unit cost for the items in this BOE are captured in separate spreadsheets listed here.

4140-00018_Cable_BOE_RSN
4140-00019_Connectors_BOE_RSN
4140-00020_CTA_BOE_RSN

RSN Material List Basis of Estimate Sheet - Connectors

Item	Est Cost/Meter	Quote List	Detail
ROV Electrical	$ 10,000	4120-00001	
ROV Hybrid	$ 35,000	4120-00001	
ROV Optical	$ 20,000	4120-00001	
Dry Electrical	$ 500	4120-00004	
Dry Hybrid	$ 1,000		
Total			

Doc Num	4140-00019	Notes:
Estimated By		
Revision	Ver_2-01	
Date	10/31/2008	
Approved By		
Date		

This example is from 4140-00019_Connectors_BOE_RSN
each line item is described with a unit cost applicable a vendor quote to support the estimate.

The cost for the ROV wet mateable connectors is one of the higher dollar items so two detailed quotes were received early in the program for this estimation, Quote #4120-00001 and 4120-00002.

ODI
A Teledyne Majority Owned Company

- Budgetary Quotation # 11268 -

Ocean Design is pleased to
offer the following quotation:

Date: 7-May-07
To: University of Washington
Attn: Mr. Tim McGinnis
Re: NEPTUNE US Project

The following pricing includes Ocean Design's standard Factory Acceptance Testing (FAT) in accordance with our latest FAT procedures.

		Budgetary Quote 11268		Conn/Assy Qtys		University of Washington		
Item	No. of Line Items	Unit	ODI Assembly Part Number (Type Designation)	Qty Per Line Item	TOTAL QTY	Line Item Unit Price Qty 1-5	Line Item Unit Price Qty 6-10	Line Item Unit Price 11+
1	1	**Jumper Assembly, High Pressure, 12-Way ROV Bulkhead Receptacle to 12-Way Bulkhead Penetrator, with CAT-5e and 5' Pigtails consisting of:**	1037470 (COS-034-01)			$10,121	$9,741	$9,474
1.1	1	12-Way ROV Bulkhead Fixed Receptacle (Sockets) with 90° JIC Hose Termination - Titanium CP, Gr2 Shell		1	1			
1.2	1	3.35m x 12-Way Fluid Filled Hose Assembly		1	1			
1.3	1	12-Way High Pressure Bulkhead Penetrator with Straight JIC Hose Termination & 1.5m Wire Pigtails with RJ-45 Connector - Titanium CP, Gr2 Shell		1	1			

Excerpt from ROV Wet Mate Quote

Cable cost were based on specific quotes for the amount of copper needed to support the power and distance requirements of the baseline infrastructure and historical quotes from similiar cabled observatories.

Labor is allocated between documenting the required components and then issuing the purchase orders.

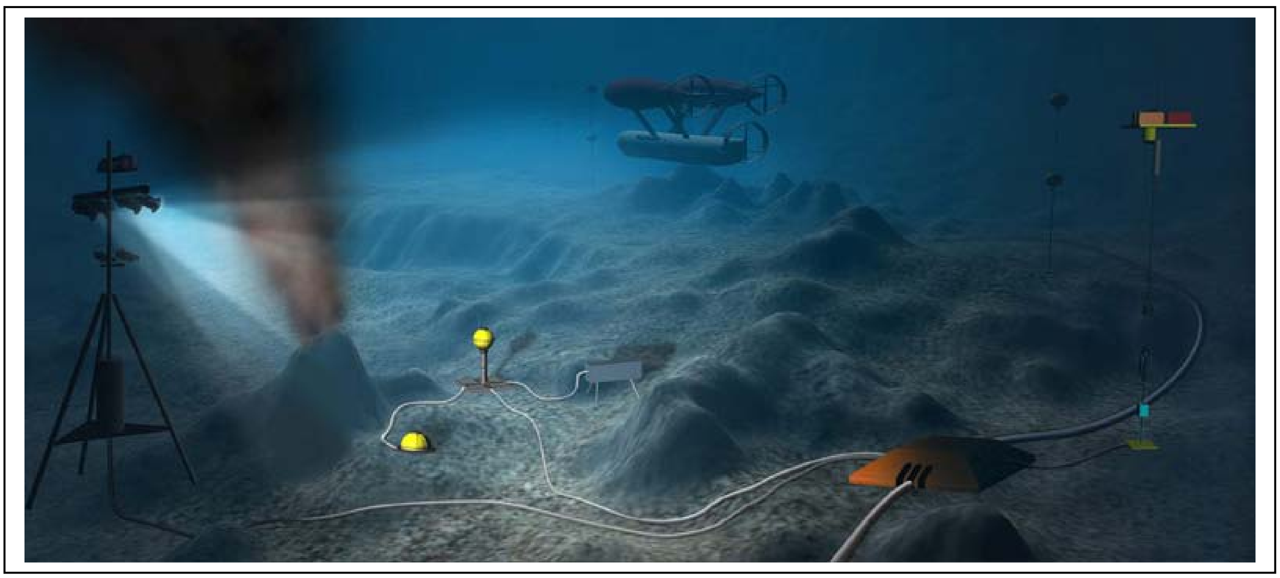
For the procurement of all materials needed in each year of building Secondary Infrastructure Nodes the following resources are assigned over a 2 month period.

Material Procurement

Resource	Hours
UW APL Senior Ocean Engineer	60
UW APL Field Engineer	60

Regional Scale Nodes
Operations and Maintenance
Secondary Infrastructure Nodes
Basis of Estimate

Version 1-00



Prepared by
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Table of Contents

1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). The document contains the Basis of Estimate for the Operation and Maintenance phase of the program for the Secondary Infrastructure Junction Boxes, Low Voltage Nodes, and Instrument Interface Boxes. This document will include the quantities of nodes built during the first five years of O&M what will be used for maintaining the Nodes installed in the Baseline configuration, the unit cost justification for the parts and labor to build the nodes and the justification for the annul recurring maintenance cost once the system is in steady state.

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name
2.4.1.3.7	CA	Secondary Infrastructure - 2012
2.4.1.3.7.21.1	S	EQUP - J Box Spares 2012
2.4.1.3.7.22	WP	Secondary Nodes Spares 2012
2.4.1.4.7	CA	Secondary Infrastructure - 2013
2.4.1.4.7.21.1	S	EQUP - Secondary Node Spares 2013
2.4.1.4.7.22	WP	Secondary Nodes Spares 2013
2.4.1.5.7	CA	Secondary Infrastructure - 2014
2.4.1.5.7.21.1	S	EQUP - Secondary Node Spares 2014
2.4.1.5.7.22	WP	Secondary Nodes Spares 2014
2.4.1.6.7	CA	Secondary Infrastructure - 2015 (Steady State)
2.4.1.6.7.23.2	S	EQUP - Secondary Infrastructure Refurbishment

2.2. Task Description

The tasks involved in calendar years 2012, 2013 and 2014 includes procuring materials, building and assembling of nodes and testing the built up systems. Sufficient quantities of units will be built to support the annual maintenance replacement strategy as defined in document # *4314-00001_OM_Secondary_Spares_Plan_RSN*. It is assumed that all systems will be fully defined during the Subsystem Development phase of the project such that no new engineering or modifications will take place under this work package. The tasks involved during steady state includes refurbishing any systems that have been replaced in the field in preparation for the next maintenance cruise and repairing any failed systems.

2.3. Estimation Technique

The unit costs for the all the secondary nodes were estimated as part of the MREFC Construction Budget. Those estimates are reused for the O & M with the correction inflation factors applied. The labor estimates are engineering estimates based the complexity of the systems compared to similar platforms built at APL for underwater observatory projects, both cabled and uncabled. The materials were estimated on a line items basis with the higher dollar items being based on quotes supplied supplemental to this BOE.

3. Budgeted Unit Quantities

Unit	2012	2013	2014
LPJBox	5		
MPJBox	2	3	
LVNode	2		
Instrument Interface Box	21	12	3

These unit quantities are based on replacement strategies as defined in document # *4314-00001_OM_Secondary_Spares_Plan_RSN* and *4308-00005_Sensor_Maintenance_Plan_RSN*. For instance there are 5 installed LPJboxes in the system that are hard wired to Instruments that must be replaced every year so 5 have been budgeted to be built for O+M for annual replacement of all 5 platforms. The Instrument Interface Boxes are tied to the quantities of spare Instruments in the system that require an Interface box to make connections to the RSN infrastructure.

4. Unit Cost Estimates

Each of the unit cost for the items in this BOE are captured in separate spreadsheets listed here.

4140-00013_MP_JBox_Unit_BOE_RSN
4140-00014_LP_JBox_Unit_BOE_RSN
4140-00016_LVNode_BOE_RSN
4140-00021_HD_Interface_Box_BOE_RSN
4140-00025_Sensor_Interface_Box_BOE_RSN

RSN Medium Power Junction Box Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Est Labor (20k/mo)	Total	Quote List	Detail
Seafloor Frame	1	$ 20,000	$ 20,000	$ 10,000	$ 30,000		Seafloor Frame - Made out of steel to hold pressure housing and ROV Connectors - Includes cost of syntactic foam.
Pressure Housing + Endplate Fab	1	$ 36,000	$ 36,000	$ 10,000	$ 46,000	4120-00012	14.8" Internal Diameter Copper Beryllium Pressure housing with endplate fabricated for Connectors
Internal Chassis	1	$ 10,000	$ 10,000	$ 10,000	$ 20,000		Internal Mounting frame for all electronics. Includes method for head transport and distribution to external pressure housing.
Ethernet Switch	1	$ 3,000	$ 3,000		$ 3,000	4120-00006	Industrial 1Gige Switch with 2 SFP Modules populated for 10km Optical Transport
DC-DC Conv	9	$ 500	$ 4,500		$ 4,500	4120-00009	48 Volt To Sensor Specific Regulated Power Supplies for science Ports and internal use. Includes Mounting PCB, Heat Distribution, Issolation Electronics and Filtering,
PPS Timing And Control	1	$ 4,000	$ 4,000		$ 4,000		This includes the Pulse Per Second and Control signal Descoding/Distribution and the required E/O Transcievers
Node Controller	1	$ 5,000	$ 5,000		$ 5,000	4120-00008	Industrial PC104 Controller Stack including the Controller and all A/D and D/A functionality needed to control the power systems and monitor the environmental status of the system. It also includes the cost of the environmental sensors
Serial to Ethernet Converter	8	$ 100	$ 800		$ 800	4120-00007	Serial to Etherenet converters on each sensor input. Can be configured for RS485 or RS232 Includes Isolation Circuit
External 400V Monitor + Distribution	1	$ 1,000	$ 1,000		$ 1,000	4120-00010	Subsystem to condition and monitor the input 400 volt conection and condition/monitor and switch the two 400 Volt output connections
Internal Wiring	1	$ 2,000	$ 2,000		$ 2,000		All internal wire harness for subsystems and connectors.
Unit Assembly	1			$ 30,000	$ 30,000		
					$ -		
					$ -		
Total			$ 86,300	$ 60,000	**$ 146,300**		

	Name	Signature Field
Doc Num	4140-00013	
Estimated By		
Revision	2-02	
Date	10/31/2008	
Approved By		
Date		

Notes: This estimate does not include any external connectors and they will be added later for each specific configuration.

This example is from 4140-00013_MP_JBox_Unit_BOE_RSN each line item is described with a unit cost, quantity and where applicable a vendor quote to support the estimate.

Labor is allocated between procuring materials, final assembly and testing of the unit.

For the procurement of all materials needed in each year of building Secondary Infrastructure Nodes the following resources are assigned over a 5 month period.

Material Procurement

Resource	Percent
UW APL Senior Mechanical Engineer	25%
UW APL Senior Electrical Engineer	13%
UW APL Electrical Engineer 4	25%
UW APL Field Engineer	100%
UW APL Electrical Engineer 3	50%

They will be responsible for ensuring the document packages are complete, creating the purchase orders and RFPs as needed, receiving, inspecting, logging and testing incoming materials.

Final Assembly and test is allocated on a per Node basis and depends on the complexity of the node in all cases 1 month is allocated for final assembly and 1 month for final test.

Instrument Interface Box

Resource	Hours
Final Assembly	
UW APL Electrical Engineer 4	16
UW APL Field Engineer	40
Final Test	
UW APL Electrical Engineer 4	16
UW APL Field Engineer	80

LP JBox

Resource	Hours
Final Assembly	
UW APL Electrical Engineer 4	48
UW APL Field Engineer	160
Final Test	
UW APL Electrical Engineer 4	48
UW APL Field Engineer	160

MP JBox

Resource	Hours
Final Assembly	
UW APL Electrical Engineer 4	120
UW APL Field Engineer	240
Final Test	
UW APL Electrical Engineer 4	120
UW APL Field Engineer	240

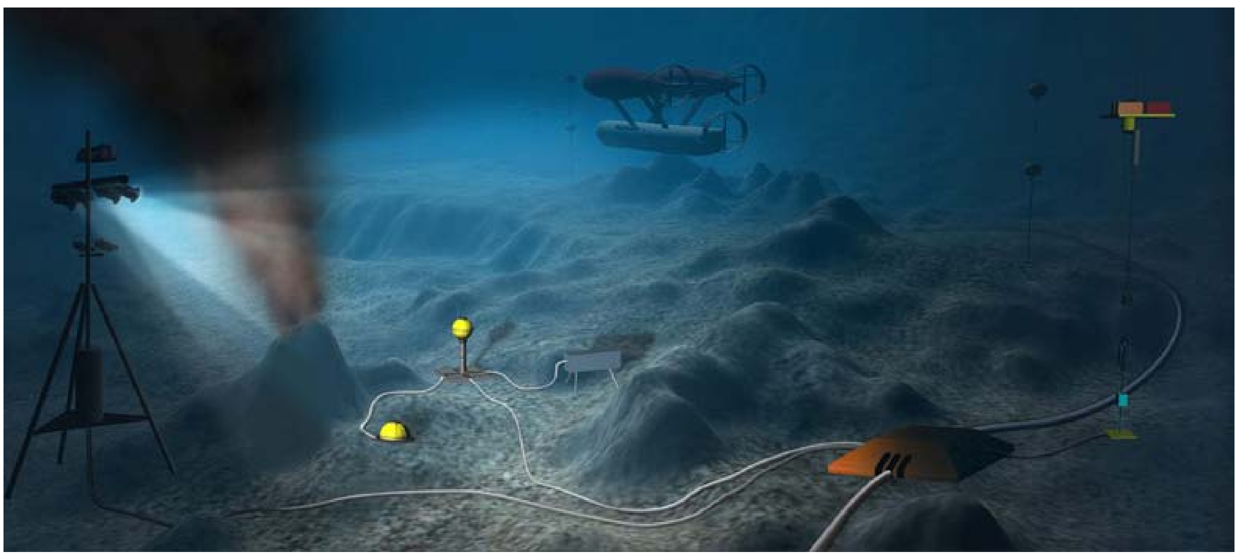
LVNode

Resource	Hours
Final Assembly	
UW APL Senior Mechanical Engineer	80
UW APL Senior Electrical Engineer	40
UW APL Electrical Engineer 4	80
UW APL Field Engineer	320
Final Test	
UW APL Senior Mechanical Engineer	80
UW APL Senior Electrical Engineer	40
UW APL Electrical Engineer 4	120
UW APL Field Engineer	240

5. Steady State

The steady state estimate for Secondary Infrastructure Nodes includes the estimated cost of materials to refurbish and nodes that were swapped out on a maintenance cruise and any damage to units that need to be repaired or replaced. Approximately 5 LPJBoxes and 3 MPJBoxes and 15 Instrument Interface Boxes will be refurbished every year. The total cost of these units is approximately $1.5 Million dollars, but a significant portion of that is in Titianium Pressure housings and connectors that are both expected to last 25 years with no refurb cost. $100k is allocated for materials for the Secondary Nodes.

Regional Scale Nodes
Operations and Maintenance
Secondary Infrastructure
Vertical Moorings
Basis of Estimate
Version 1-00



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Version	Release Date	Description	By
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1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). The document contains the Basis of Estimate for the Operation and Maintenance phase of the program for the Secondary Infrastructure Vertical Moorings including the Deep and Shallow Profilers. This document will include the quantities of components built during the first five years of O&M that will be used for maintaining the Moorings installed in the Baseline configuration, the unit cost justification for the parts and labor to build the components.

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name
2.4.1.4.7	CA	Secondary Infrastructure - 2013
2.4.1.4.7.21.2	S	EQUP - Vertical Mooring + Profilers Spares 2013
2.4.1.4.7.21.2.1	S	EQUP - UW_APL_NODE_Mooring Controller Spares 2013
2.4.1.4.7.21.2.2	S	EQUP - Shallow Profiler Spares 2013
2.4.1.4.7.23	WP	Vertical Mooring + Profilers Spares 2013
2.4.1.5.7	CA	Secondary Infrastructure - 2014
2.4.1.5.7.21.2	S	EQUP - Secondary Node Spares 2014
2.4.1.5.7.21.2.1	S	EQUP - Float Junction Box Spares 2014
2.4.1.5.7.21.2.2	S	EQUP - Deep Profiler Spares 2014
2.4.1.5.7.21.2.3	S	EQUP- Vertical Mooring Structure Spares 2014
2.4.1.5.7.23	WP	Vertical Mooring + Profilers Spares 2014

2.2. Task Description

The tasks involved in calendar years 2013 and 2014 includes procuring materials, building and assembling of components and testing the built up systems. Sufficient quantities of units will be built to support the annual maintenance replacement strategy as defined in document # *4314-00001_OM_Secondary_Spares_Plan_RSN*. It is assumed that all systems will be fully defined during the Subsystem Development phase of the project such that no new engineering or modifications will take place under this work package.

2.3. Estimation Technique

The unit costs for the all the Vertical Moorings and Profilers were re-estimated as part of the Vertical Mooring and Profilers Preliminary Design Review. The original estimates used for the baseline Construction Project Budget needed to be updated to match both a new configuration as well as a decision to build the profilers at APL due to lack of viable industry solutions. Those estimates used existing quotes for connectors and cables but built up a more detailed budget that is summarized in the attached unit cost for spares sheets.

The labor estimates are engineering estimates based the complexity of the systems compared to similar platforms built at APL for underwater observatory projects, both cabled and uncabled. The materials were estimated on a line items basis with the higher dollar items being based on quotes supplied supplemental to this BOE. APL has recent experience building a similar Vertical Mooring with Profiler system that is documented in *4140-00011_Aloha_Mooring_Suplimental_Request* and *4140-00012_Aloha_Replication_Spreadsheet.*

3. Budgeted Unit Quantities

Unit	2013	2014
Deep Profiler Vehicle		3
Deep Profiler Mooring		1
Shallow Profiler	3	
Vertical Mooring Spares		1
Float Junction Box		3
Mooring Controller	3	

These unit quantities are based on replacement strategies as defined in document # *4314-00001_OM_Secondary_Spares_Plan_RSN*. The general strategy is to have full replacements for the components that can be replaced each year with an ROV like the Shallow Profiler and Deep Profiler Vehicle, but to only have spare components to fix failed infrastructure components like the mooring cables and platforms. The Spares for the Vertical Mooring are built later in the program to match the build of the Construction units which fall in 2013 and 2014 for installation in 2014.

4. Unit Cost Estimates

Each of the unit cost for the items in this BOE are captured in separate spreadsheets listed here.

4140-65989_Vertical_Mooring_Spares_BOE_RSN
4140-66399_Instrument_Module_VM_Spares_BOE_RSN
4140-64538_Deep_Profiler_Spares_BOE
4140-64539_Shallow_Profiler_Spares_BOE

RSN Vertical Mooring Spares Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Modules	Quote List	Detail
EOM Cable						
ROV Hybrid Connectors	2	$ 35,000	$ 70,000		4120-0001	
Mooring Cable	3.2(km)	$ 55,000	$ 176,000		4120-0003	
Mooring Cable Termination	2	$ 10,000	$ 20,000	$ 266,000	4120-0002	
Seafloor Cable						
ROV Hybrid Connectors	2	$ 35,000	$ 70,000	$ 70,000	4120-0001	
Anchor System						
Anchor	2	$ 16,000	$ 32,000			
Releases	4	$ 20,000	$ 80,000	$ 112,000		
200 M Platform						
Structural Titanium	1	$ 25,000	$ 25,000			
Sytactic Foam	1	$ 60,000	$ 60,000	$ 85,000		
Misc						
EOM Cable Floats	50	$ 1,000	$ 50,000			
Structural Ti for Aux Frame	1	$ 20,000	$ 20,000			
Misc Material	1	$ 33,000	$ 33,000	$ 103,000		
Sub Totals			$ 636,000	$ 636,000		
Total Mooring System						

	Name	Notes: See 4140-00011 and 4140-00012 for Aloha Mooring Replication Cost Information
Doc Num	**4140-00023**	
Estimated By	**Cram**	
Revision	**1-00**	
Date	**2/1/2011**	
Approved By		
Date		

This example is from 4140-65989_Vertical_Mooring_Spares_BOE_RSN.
Each line item is described with a unit cost, quantity and where applicable a vendor quote to support the estimate.

Labor is allocated between procuring materials, final assembly and testing of the unit.

For the procurement of all materials needed in each year of building Secondary Infrastructure Vertical Mooring Equipment the following resources are assigned over a 5 month period.

Material Procurement

Resource	**Percent**
UW APL Senior Mechanical Engineer	25%
UW APL Senior Electrical Engineer	13%
UW APL Electrical Engineer 4	25%
UW APL Field Engineer	100%
UW APL Electrical Engineer 3	50%

They will be responsible for ensuring the document packages are complete, creating the purchase orders and RFPs as needed, receiving, inspecting, logging and testing incoming materials.

Final Assembly and test is allocated on a per unit basis and depends on the complexity of the component.

Mooring Controller

Resource	Hours
Final Assembly	
UW APL Senior Mechanical Engineer	80
UW APL Senior Electrical Engineer	80
UW APL Electrical Engineer 4	80
UW APL Field Engineer	240
UW APL Electrical Engineer 3	80
Final Test	
UW APL Senior Mechanical Engineer	80
UW APL Senior Electrical Engineer	80
UW APL Electrical Engineer 4	80
UW APL Field Engineer	240
UW APL Electrical Engineer 3	80

Shallow Profiler

Resource	Hours
Final Assembly	
UW APL Senior Mechanical Engineer	320
UW APL Senior Electrical Engineer	320
UW APL Electrical Engineer 4	320
UW APL Field Engineer	960
UW APL Electrical Engineer 3	320
Final Test	
UW APL Senior Mechanical Engineer	80
UW APL Senior Electrical Engineer	80
UW APL Electrical Engineer 4	80
UW APL Field Engineer	320
UW APL Electrical Engineer 3	80

Float JBox

Resource	Hours
Final Assembly	
UW APL Senior Mechanical Engineer	15
UW APL Senior Electrical Engineer	15
UW APL Electrical Engineer 4	10
UW APL Field Engineer	50
UW APL Electrical Engineer 3	30
Final Test	
UW APL Senior Mechanical Engineer	15
UW APL Senior Electrical Engineer	15

UW APL Electrical Engineer 4	10
UW APL Field Engineer	50
UW APL Electrical Engineer 3	30

Deep Profiler

Resource	**Hours**
Final Assembly	
UW APL Senior Mechanical Engineer	160
UW APL Senior Electrical Engineer	160
UW APL Electrical Engineer 4	160
UW APL Field Engineer	480
UW APL Electrical Engineer 3	160
Final Test	
UW APL Senior Mechanical Engineer	80
UW APL Senior Electrical Engineer	80
UW APL Electrical Engineer 4	80
UW APL Field Engineer	160
UW APL Electrical Engineer 3	80

Regional Scale Nodes Operations and Maintenance Primary Infrastructure Spares Basis of Estimate

Version 1-00

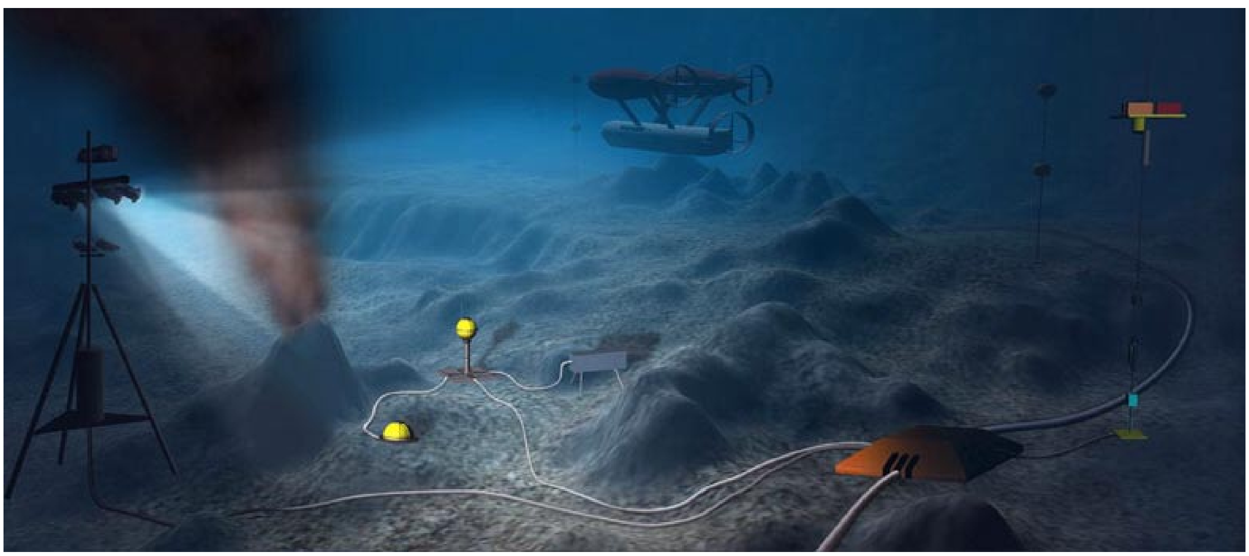

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Table of Contents

1. Introduction

The Regional Scale Nodes (RSN) cabled ocean observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF) funded Ocean Observatories Initiative (OOI). This document contains the Basis of Estimate for the Operation and Maintenance phase of the program for the O&M Spares for the Primary Infrastructure. The Primary Infrastructure contract was awarded to L-3 MariPro Communications in November 2009.

This document includes the O&M Billing Milestones associated with the L-3 MariPro Communications Primary Infrastructure contract.

2. Summary Information

2.1. WBS Table

Applicable WBS Numbers supported by this BOE:

WBS #	Element Type	Name	WBS Definition
2.4.3	S	O&M Spares	This summary account captures the Primary Infrastructure Spares Operations & Maintenance portion of the contract signed November 2009 with L-3 Communications MariPro. The spares will include various lengths of cable, repeaters, primary nodes, splicing kits, test equipment and cable station equipment components. The Billing Schedule defines the schedule and milestones.
2.4.3.2	C	Primary Infrastructure Spares (2011)	This control account captures the Primary Infrastructure Spares Operations & Maintenance Billing Milestones for O&M Calendar Year 2 (2011).
2.4.3.2.0	W	SPA - Primary Infrastructure Spares (2011)	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Primary Infrastructure Spares (2011) through 4/30/2011.
2.4.3.2.20	W	O&M Submarine Cable Procurement Complete	This work package captures one of the subcontract Billing Milestones associated with the order of the spare submarine cable for Axial and Hydrate Ridge cable lines. Spare submarine cable would be utilized to repair a cable fault.
2.4.3.2.21	W	O&M Land Cable and Spare SLTE Installed	This work package captures one of the subcontract Billing Milestones associated with the installation of the land cable between the beach manhole and the shore station and the spare Submarine Line Terminating Equipment.
2.4.3.2.22	W	O&M Submarine Cable Delivered	This work package captures one of the subcontract Billing Milestones associated with the delivery of the spare Submarine Cable.
2.4.3.3	C	Primary Infrastructure Spares	This control account captures the Primary Infrastructure

WBS #	Element Type	Name	WBS Definition
		(2012)	Spares Operations & Maintenance Billing Milestones for O&M Calendar Year 3 (2012).
2.4.3.3.20	W	Spare Terminal Test Equipment (TTE) Delivered	This work package captures one of the subcontract Billing Milestones associated with the delivery of the spare Terminal Test Equipment (TTE).
2.4.3.3.21	W	Spare Manufacturing Primary Nodes Complete	This work package captures one of the subcontract Billing Milestones associated with the completion of the Primary Node manufacturing.
2.4.3.3.22	W	Delivery of Simulators	This work package captures one of the subcontract Billing Milestones associated with the delivery of the Simulators.
2.4.3.3.23	W	System Acceptance	This work package captures one of the subcontract Billing Milestones associated with System Acceptance.
2.4.3.4	C	Primary Infrastructure Spares (2012)	This control account captures the Primary Infrastructure Spares Operations & Maintenance Billing Milestones for O&M Calendar Year 3 (2012).
2.4.3.4.20	W	Provisional Acceptance Test Documents Complete	This work package captures one of the subcontract Billing Milestones associated with Test Documents complete.

2.2. Task Description

The tasks involved in calendar years 2011, 2012 and 2013 includes the procurement of spare equipment including, but not limited to, submarine and land cables, submarine repeater, submarine and cable jointing kits, and spare Primary Node (BIA and SIA). Sufficient quantities of units will be supplied to support at least one repair at-sea operation.

2.3. Estimation Technique

The costs associated with this Control Account are actual negotiated costs and are based on contractual Billing Milestones.

3. Budgeted Cost

The costs associated with this Control Account are actual negotiated costs and are based on contractual Billing Milestones.

MariPro

O&M

Est Date	Program Event	Acceptance Criteria	O&M Payment		Cum Payments		% of O&M
22-Jan-10	Contract Award	Signature of both parties on the Contract.	$896,610		$896,610		8.16%
5-Feb-10	Conduct System Requirements Review (SRR)	Signed certification by L-3 on the subject invoice that it has conducted this review. (Note: Closure of action items associated with this review is not a condition for the milestone payment.)	$896,610		$1,793,220		8.16%
31-May-10	Conduct Simulators Preliminary Design Review (PDR)	Signed certification by L-3 on the subject invoice that it has conducted this review. (Note: Closure of action items associated with this review is not a condition for the milestone payment.)	$896,610		$2,689,830		8.16%
24-Nov-10	Conduct Simulators and Commission Hardware Critical Design Review (CDR)	Signed certification by L-3 on the subject invoice that it has conducted this review. (Note: Closure of action items associated with this review is not a condition for the milestone payment.)	$896,610		$3,586,440		8.16%
18-Jan-11	O&M Land Cable Procurement Order Placed	Signed certification by L-3 on the subject invoice that the purchase order(s) for land cable required for the Contract is released.	$896,610		$4,483,050		8.16%
21-Mar-11	O&M Submarine Cable Procurement Complete	Signed certification by L-3 on the subject invoice that the purchase order(s) for the wet	$1,344,915		$5,827,965		12.24%

Est Date	Program Event	Acceptance Criteria	O&M Payment		Cum Payments		% of O&M
		cable required for the Contract is released.					
1-Jun-11	O&M Land Cable and Spare SLTE Installed	Signed certification by L-3 on the subject invoice that the O&M Land Cable and SLTE have been installed and subjected to internal acceptance test requirements and have successfully passed the same.	$448,305		$6,276,270		4.08%
30-Aug-11	O&M Submarine Cable Delivered	Signed certification by L-3 on the subject invoice that it has taken receipt of the O&M wet cable from its vendor.	$2,241,525		$8,517,795		20.41%
27-Jun-12	Spare Terminal Test Equipment (TTE) Delivered	Signed certification by L-3 on the subject invoice that the required spare TTE has been delivered.	$448,305		$8,966,100		4.08%
30-Jun-12	Spare Manufacturing Primary Nodes Complete	Signed certification by L-3 on the subject invoice that the required spare Primary Nodes have been subjected to internal acceptance test requirements and have successfully passed the same.	$224,153		$9,190,253		2.04%
30-Aug-12	Delivery of Simulators	Signed certification by L-3 on the subject invoice that the simulator has been delivered.	$896,610		$10,086,863		8.16%

L3 MariPro

Est Date	Program Event	Acceptance Criteria	O&M Payment		Cum Payments		% of O&M
31-Dec-12	System Acceptance	Signed certification by L-3 on the subject invoice that the System Acceptance has been subjected to internal acceptance test requirements and have successfully passed the same.	$448,305		$10,535,168		4.08%
27-Feb-13	Provisional Acceptance Test Documents Complete	Issuance of System Acceptance Certificate of Service by UW.	$448,305		$10,983,473		4.08%
	Total		$10,983,473				100.00%

L-3 MARIPRO PROPRIETARY
Use or disclosure of data contained on this sheet is subject to the restriction on the title page of this document.

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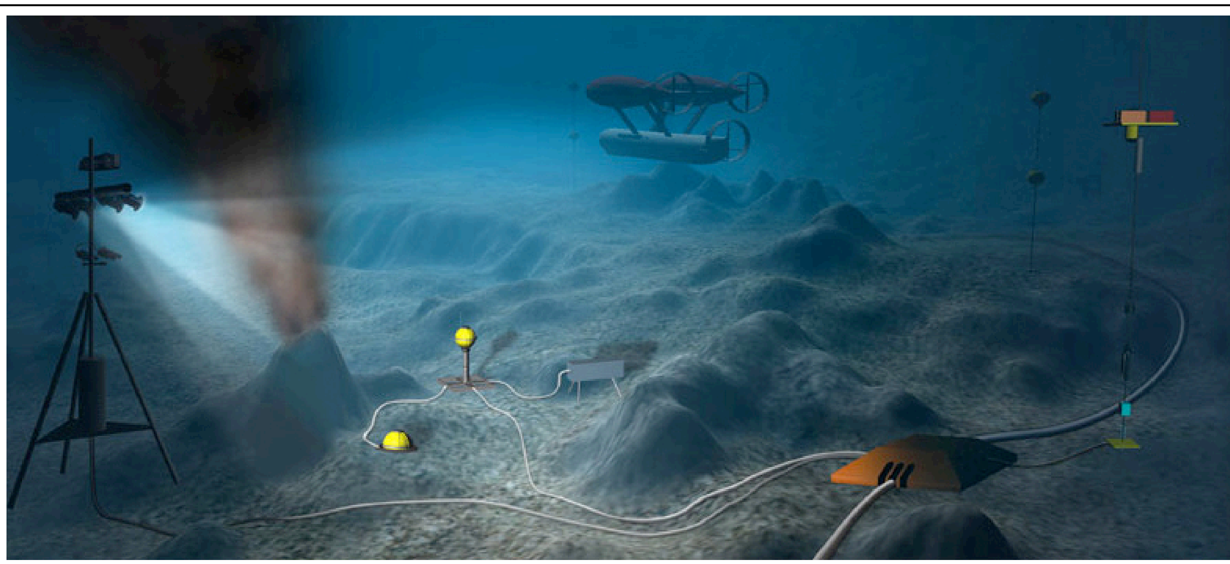
4. Steady State

The Primary Infrastructure is designed to last 25 years with no refurbishment costs.

Primary Infrastructure spares for repair operations are acquired during Years 2010 through 2013; and no steady state costs are associated with this Control Account.

Regional Scale Nodes Maintenance Cruises Basis of Estimate

Version 1-00



Prepared by
University of Washington for the
Ocean Observatories Initiative
May 5, 2011

Document Number 4140-65988

Document Control Sheet

Version	Release Date	Description	By
1.0		Initial Version	D.Kelley

Table of Contents

1.0 Introduction

The Regional Scale Nodes (RSN) cabled observatory off the coast of Washington and Oregon is part of the National Science Foundation (NSF)funded Ocean Observatories Initiative (OOI). This document contains the Basis of Estimate for the Field Operations component of the RSN during the Operations and Maintenance phase of the program. This document will include quantities for the number of ship and remotely operated vehicle (ROV) days per year, the staffing requirements for each cruise, required equipment, and justification the annual recurring maintenance costs steady state field operations.

2.0 Summary Information

2.1 WBS Table

Applicable WBS Numbers supported by this BOE

WBS#	Element Type	Name
2.4.1.5.8	WP	Maintenance Cruise 1-2014
2.4.1.6.8	WP	Maintenance Cruse 1-2015
2.4.1.6.9	WP	Maintenance Cruise 2-1015
2.4.1.7.8	WP	Maintenance Cruse 1-2016
2.4.1.7.9	WP	Maintenance Cruise 2-1016

2.2 Task Description

Calendar year 2014 begins the transition into the at-sea phase of Field Operations with the first Operations and Maintenance (O&M) cruises taking place at Southern Hydrate Ridge and Axial Seamount to maintain Secondary Infrastructure (e.g. extension cables, junction boxes, sensors). In calendar years 2015-2016 O&M field operations will be in the steady-state phase. Construction to transition to O&M field operations is as follows:

- 2011 20 days with the R/V Thompson and the Canadian Remotely Operated Vehicle ROPOS for site validation of Secondary Infrastructure at Southern Hydrate Ridge and Axial Seamount.
- 2013 60 days with the R/V Thompson and an ROV to deploy extension cables, junction boxes and secondary nodes at Southern Hydrate Ridge and at the summit of Axial.
- 2014a 49 days with the R/V Thompson and an ROV to deploy hybrid water column moorings and benthic packages at the Slope Base (PN1A), base of Axial Seamount (PN3A), and at the ~600 m site at Gary's Bad Hang in conjunction with Coastal Global (PN3C). An ROV is required to plug in wet-mateable cables to secondary nodes supplying power to the moorings and bottom benthic packages.
- 2014b 20 days with the R/V Thompson and an ROV for the first O&M cruise to recover and redeploy Secondary Infrastructure, as needed, at Southern Hydrate Ridge and Axial Seamount.
- 2015 40 days with the R/V Thompson and an ROV will begin the routine "O&M" phase

of the program.

2.3 Estimate Technique

The costs for Field Operations were based in part on the MREFC Construction Budget. Because RSN infrastructure has not yet been installed, at-sea day requirements were estimated based on installation scenarios for Secondary Infrastructure and labor costs were estimate based on staffing requirements for past cruises using ROV's and mooring deployments. Example scenario documents included in this package are: Secondary Infrastructure as outlined in the Hydrate Ridge Installation Scenario (4315-00001) and PN1A Mooring Deployment Scenario (4315-66407)**.** The materials were estimated on a line-item basis based on past cruise experience and anticipation of requirements for the O&M phase of the program. Past cruise experience using ROV's includes over a decade of use with numerous ROV's (Jason 1 and 2, ROPOS, Tiburon) for complex field programs and installation of >20 uncabled in-situ sensors (e.g. broadband and short-period seismometers, microbial incubators, current meters, cameras, thermistor arrays, resistivity probes and time-series samplers for fluids and microbial DNA).

2.3.1 Assumptions

Assumptions used in this estimate include:

- The R/V Thompson will be the ship used during RSN O&M cruises. Staffing and deck space requirements are significant for the O&M cruises. The Thompson hosts 36 science berths, and is 274' in length.
- The R/V Thompson will mobilize at the School of Oceanography dock and either Astoria or Newport Oregon. Newport is the closest port to Southern Hydrate Ridge. Newport and Astoria are ~ equal distance from Axial Seamount.
- RSN operation periods (June-September) are based on the weather window defined by three decades of UNOLS operations in the NE Pacific. Cruise durations are based on estimates of required time to deploy the full-water column moorings and associated benthic packages (4315-66407) and Secondary Infrastructure at Southern Hydrate Ridge (4315-00001 Hydrate Ridge Installation Scenario).
- Operation and ship operations are around the clock. 24/7 ROV operations require 4-7 watch standers routinely working 4-on, 8-off shifts. Watch leaders may stand as long as 12 hr shifts depending on operations.
- Assume ~4 hr turn around time for ROV with coupling of nodes to the vehicle. This insures efficiency and lowers risk for deployments.
- Assume that the traction winch and ROV are mobilized on the ships fantail during a single cruise. This optimizes efficiency and decreases costs associated with remobilization of heavy lift cranes and multiple trips to port.

3. Budgeted Unit Quantities

Unit (section)	2014	2015	2016
Ship Days (4.1)	20	40	40
ROV Days (4.2)	20	40	40
Mobilization (4.3)			
At-sea Staffing (4.4)	9 Engineers 9 Science/Data	9 Engineers 9 Science/Data	9 Engineers 9 Science/Data
Satellite Time (4.5)	20	40	40
Digital Storage (4.6)			
Cal-Val Consumables (4.7)			

4.0 Unit Cost Estimates

4.1 Ship Day Rates: The cost estimate for ship days assumes use of the University-National Oceanographic Laboratory System (UNOLS) ship the R/V Thompson owned by the Office of Naval Research. It is operated under a Charter Party agreement by the School of Oceanography at the University of Washington as part of the UNOLS fleet. The day rates are established by the operators based on the annual cost by the number of "operational days". The day rate for the Thompson is based on a 2011 rate of $46,820 and an inflation factor of 8% (this rate takes into account projected increases in fuel cost and ship personnel).

4.2 ROV Day Rates: The day rate for the ROV is based on a 2011 rate of $19,943 utilizing quotes from the National Deep Submergence Facility for ROV Jason work completed in 2010 (see quote **4120-66404**) and from the Canadian Scientific Submergence Facility ROV ROPOS quote for work to be completed in 2011(see quote **4120-4120-66405**). Note that an RFP will be completed in 2011 for the ROV to be used in 2012-2016. Cost of ROV personnel (10 each cruise) are included in the day rate.

4.3 Ship and ROV Mobilization-demobilization: Mobilization-demobilization costs for cruises includes those incurred for placing the ROV, optical traction winch, and vans onboard, and crane rentals. Mobilization costs for the ROV are based on those for ROPOS ($107,400; **4120-4120-66405)**. These costs are similar to those of Jason, which generally charges 4 mobilization and 2 demobilization days/cruise ($19,997/day; $119,982; **4120-66404**).

4.4 At-sea Staffing Labor Costs: At-sea staffing costs are split between the School of Oceanography (science and data personnel) and the Applied Physics Laboratory (Engineering). The O&M costs include sea-pay as required for UW professional staff: other at-sea salaries are covered under Project Management and Sustaining Engineering at the School of Oceanography and Applied Physics Laboratory (respectively). Rates for sea-pay are set by the School of Oceanography and Applied Physics Laboratory. The estimates are based on an at-sea staff of 9 scientists and 9 engineers (Figure 1), and a work-week of 44 hrs.

4.4.1 RSN At-Sea: A critical component for successful expeditions is careful staffing of cruises. For the RSN, staffing requirements are based on the UW's 20 years of past cruise experience using ROV's and deployment of uncabled instrument packages and engineering. Almost all RSN O&M cruises will include the use of an ROV for installation of extension cables, secondary nodes, junction boxes, benthic packages, and instruments. The only exception to this, may be cruises exclusively dedicated to deploying the full water column moorings at the

Slope Base (PN1A), the Endurance hybrid mooring at Gary's Bad Hang (PN1C), and Axial Seamount (PN3A). ROV's will be required to deploy the associated benthic packages and to connect the mooring to the low power nodes.

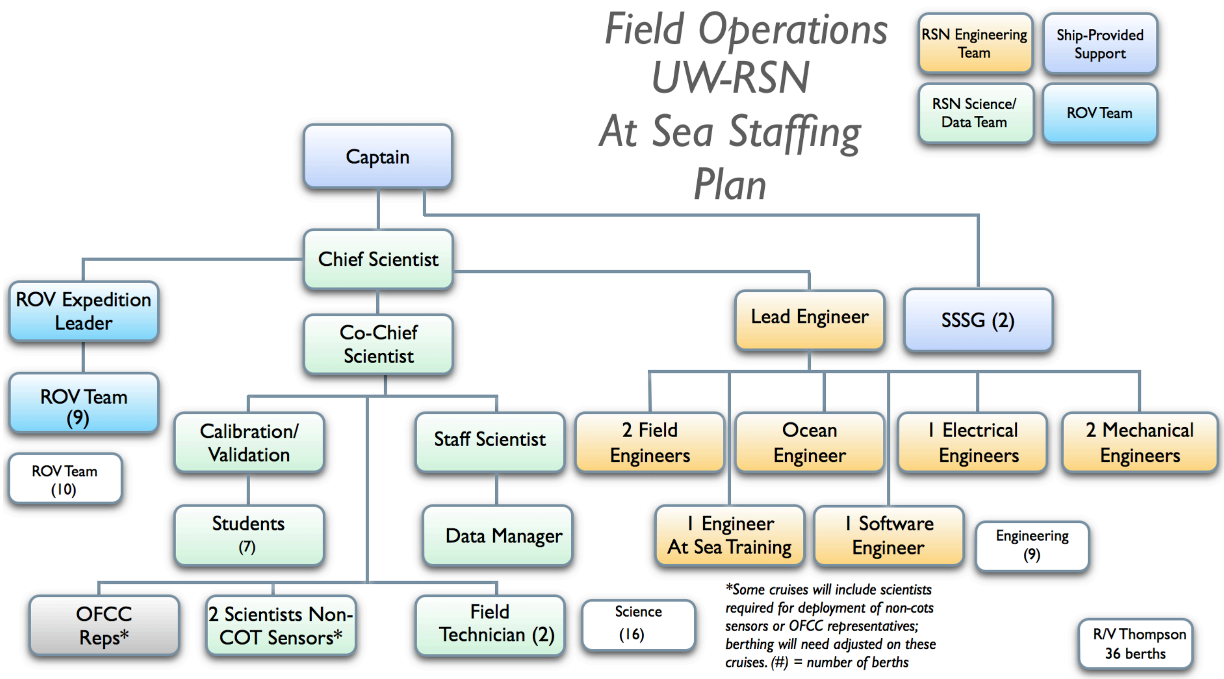


Figure 1. Staffing requirements for RSN cruises during O&M. These requirements are based on several decades of sea-going experience using ROV's and deployment of marine infrastructure. The ship operators provide two Shipboard Science Support Group staff that are liaisons with the Science Team and R/V Thompson crew and they facilitate over-the-side operations of science equipment (e.g. CTD's). The size of the ROV teams are set by the ROV facility. The NDSF vehicle Jason requires 10 personnel.

Cruise staffing for ROV expeditions includes three major teams: 1) the ROV team that will consist of an Expedition Leader and 9 other members; 2) the Science Team that includes the Co-Chief and Chief Scientists, a science staff, and Ocean 460 students, totaling ~ 16 members; and 3) the Engineering team that will vary from 9-11 members depending on operational requirements. For RSN ROV expeditions, the specific staff makeup of the installation and O&M cruises will vary somewhat depending on the operational requirements. However, a general staffing model for RSN-ROV cruises is illustrated in Figure 1. Total berthing for the R/V Thompson is 36.

Science Team: For most RSN cruise requiring an ROV, the Science Team will include ~ 16 members (including graduate and undergraduate students as part of the UW educational effort). The benefit of using ROV's, in contrast to submersibles, for cabled observatory work is that they can work 24/7 for as long as it takes to complete operations, however, this also means that there is a fire-hose of data "flowing up" the fiber to the ship 24/7: this requires intense watch-standing efforts. Scientific ROV teams stand watches of 12 hrs (e.g. ROPOS) to 4hrs (e.g. Jason) and include, for a given watch, a tether management person, a pilot, and a navigator (Figure 2). In addition to this, a scientific-engineering support group must be supplied from the Science Team.

Chief Scientist (CS): The ship Captain has the full and final responsibility for the safety of the ship and all personnel aboard. Because of this responsibility, he/she has full authority over all operations and personnel, both crew and scientific party. In all decisions regarding safety, the Captains authority is absolute. The CS is responsible for overseeing all science operations at sea and he/she has frequent interactions with the Captain. The CS is responsible for the personal conduct of the shipboard scientific party. A critical role of the CS will be to make tough at-sea-decisions without conflict induced by self-interest in any one experiment (e.g., changing installation schedules of sensors due to weather or instrument failures). The CS will interface with the Captain, Operations Center Manager, Chief Engineer and PIs, to ensure smooth operations and completion of goals. The CS will hold shipboard science meetings to keep all science party informed of operations.

Co-Chief Scientist (CCS): The CCS aides the CS in all aspects of cruise operations. Because RSN at-sea operations run 24/7, it is important to have another person with extensive experience in all aspects of RSN cruise requirements who can help carry the load of the CS. The CCS also works closely with the Staff Scientist and Data Manager to insure that at-sea documentation of daily science and engineering operations are complete, as well as data archiving.

Staff Scientist: The Staff Scientist will ensure that documentation critical for site characterization, instrument deployment, and CI-requirements are met. The Staff Scientist will be in charge of writing detailed daily science operations reports and cruise reports for each cruise. These reports will be provided online. The Staff Scientist will interface with a Data Manager on each cruise.

Calibration and Validation Technician: The Cal/Val Technician will oversee all calibration and validation sampling and analyses conducted on the O&M cruises. Estimates for costs associated with sampling and analyses are provided in section 4.5 of this document. This person will oversee set up and maintenance of ship-board equipment required to analyze the samples, and in sure that shore-based samples are well documented and stored properly. He/she will also over see the students who will help analyze the samples (i.e. titration for oxygen concentrations).

Data Manager: The Data Manager ensures that all cruise data are well-organized, documented, (e.g., video data, still imagery, CTD data, deployment information, and sample inventories) and complete prior to demobilization.

Field Technician (2): The Field Technicians will insure that all ROV data and other science data are collected and archived completely with backups. This will include variably compressed HD video imagery, digital still imagery, vehicle navigation, and bathymetry. The Field Technician will update GIS and COVE databases for operational planning during the cruise and insure that ROV dive logs are maintained. The field technicians will help with collection of samples for sensor-instrument validation (e.g. salinity, dissolved oxygen, chlorophyll, pH etc) and will help with shipboard analytical equipment (e.g. titrators). They will also help insure proper storage of samples for follow-on shorebased analyses (e.g. nutrients) at the UW Water Center. They will also insure that all Science Equipment is mobilized and demobilized via maintenance of a science gear inventory.

Non-Cots Scientists: On some cruises, berths will need to be available for PI-Scientists that are involved in collaborative efforts to build MREFC non-COTS sensors (e.g. RAS-PPS) that require specialized preparation immediately prior to deployment.

Students: Up to ~7 students may participate on each cruise as part of the UW Sea-going Research and Discovery class. In addition to the educational efforts, these students form an important component of the cruise because they are key members of the Watch-Standing team for ROV operations.

Engineering Team: We anticipate that during installation of the RSN and for the first couple of field seasons, a full suite of engineers (9 team members) will be required to sail to insure that all deployments go smoothly by having the right people onboard to deal with unforeseen problems.

Once O&M at-sea operations become more routine, and the wide breadth of skill sets are diversified and developed across the Engineering Team, it is likely that the membership of the Engineering Team for each cruise can be reduced.

Lead Engineer (LE): The Lead Engineer is responsible for overseeing the personal and technical conduct of the Engineering Team during the entire cruise. The LE will report to the Chief Scientist and will provide technical direction to the different engineers on the cruise. He/she will be responsible for making any engineering decisions regarding the state of the equipments and how and when they are deployed and/or retrieved. They will directly interact with the Observatory Operations Center during power cycling of the cable.

Field Engineer (FE): In general, two Field Engineers will be on each cruise. They will report to the lead engineer and will be responsible for preparing all equipment to be deployed, as well as performing any repairs to equipment found to be defective. One of the FE's will be responsible for maintaining all mechanical aspects of the equipment and the second FE will oversee the maintenance of all electrical aspects of the equipment.

Ocean Engineer (OE): The Ocean Engineer will provide scientific oversight to the engineering team. The OE will work closely with the CS and CCS to guide the installation and deployment of the scientific sensors and determine when the sensors are operating correctly. The OE will also be the main engineering contact with the ROV team and will lead the engineering team during equipment deployment and retrieval. He/she will report directly to the LE.

Electrical Engineer (EE): The Electrical Engineer will report to the LE and will be responsible for all of the RSN electrical equipment. He/she will supervise the electrical FE during the cruise.

Mechanical Engineer (ME): Normally two Mechanical Engineers will be onboard each cruise. The ME's will work closely with the OE to assure that the equipment is prepared for installation at the appropriate time. They will work closely with the deck crew and the ROV team during installation and again during equipment retrieval. They will report to the LE and will supervise the mechanical FE.

Software Engineer (SE): The Software Engineer will be responsible for the in-situ monitoring of the RSN network and the internal operation of the submerged equipment. He/she will report directly to the LE and will work closely with the control engineer's on-shore to ensure that the equipment is working correctly both before and after deployment.

Engineer Training (EIT): The Engineer-in-Training will be a junior engineer who probably has not been to sea before. He/she will be onboard the cruise to assist the engineering team in its efforts and to learn as much as possible about life and work at sea. The EIT will normally go to sea the following year as a full member of the engineering team.

ROV Team: Because ROV operations involving sensor deployment and site characterization are extremely intense and myriad, continuous data streams come up the fiber, 5-6 members of the RSN seagoing team will be required during each dive (Figure 2). These include:

Operations Director: This person will be either a scientist of engineer depending on the operational requirements. This person directs the ROV operations by directly interfacing with the ROV pilot who directs the ROV team. Typically this person has extensive experience both at-sea and with the use of ROV's. Operations Directors do not have specific length watches, but are in the control room for as long as their specific operational duties require.

Watch Leader: The Watch Leader ensures smooth operations in the ROV control center and that all logging operations are being done in a way to meet documentation requirements. They insure smooth watch transitions: Operation Directors may come and go during a watch as tasks are completed, therefore the Watch Leader is responsible for continuity of logging, operations, etc. The Watch Leader is in charge of the members of the logging team (video archive, event logger, HD imagery & stills). This person is typically a senior member of the Science Team.

Video Archive: This person is a member of the logging team, which is responsible for routine documentation of all ROV operations. The Video Archive person oversees video imagery collection (DVD burning; high definition feeds & archive). There are typically 6- 8 video feeds from the ROV and chosen streams are recorded as working and archive copies 24/7 during operations. This person is also responsible for accurately labeling and entering digital logs of the archival process.

Event Logger: Operator-specific integrated science logging systems for real-time documentation of all operations are used 24/7 when the ROV is conducting operations. High-quality event logging provides metadata that is critical to "search-driven" inquires of dive activities and post-cruise reconstruction of dive sequences. The logging systems include menu-driven event logging and the ability for the logger to digitally record comments (type of operation being conducted, issues with the operation, when and what samples are taken, when and what sensors are being deployed etc). When an event is logged, vehicle location (latitude, longitude, depth, heading) is recorded automatically. Some systems also allow concomitant frame grabbing of images.

HD imagery & Stills: Collecting appropriate imagery during operations is key for documentation of activities as well as for completion of science and education and public engagement objectives. Typically there are 2-3 science-operated controllers for the various camera systems (e.g. 1-3 HD video cameras, 1-2 digital still cameras). The imagery person is responsible for collection of high-quality video and still imagery, including adjustments of focus, zoom, sensitivity, and color calibration of the cameras. Because this is a technically demanding position, and it is essential to capture unrepeatable moments, they are typically directed by the Operations Director.

Science and Engineering Shore Communications: During installation and maintenance of the RSN, the science and engineer communications watch members will be in direct communication, as needed, with the Observatory Operations Center (OOC). It will be critical to maintain voice-over-IP direct communications to shore as well as video transmission when newly deployed secondary infrastructure is powered-up and "turned on". The engineer will insure that all operations are conducted in the correct order and that the test "check list" is completed (checking for grounds, faults etc). The science communications person will be in direct communication with the QA/QC team to insure that instrument-sensor data are meeting requirements. The Science and Engineering communications members will also work with the Watch Leader, Operations Director, Staff Scientist, Lead Engineer and Chief Scientist to insure that Daily Science and Engineering Operations reports are complete.

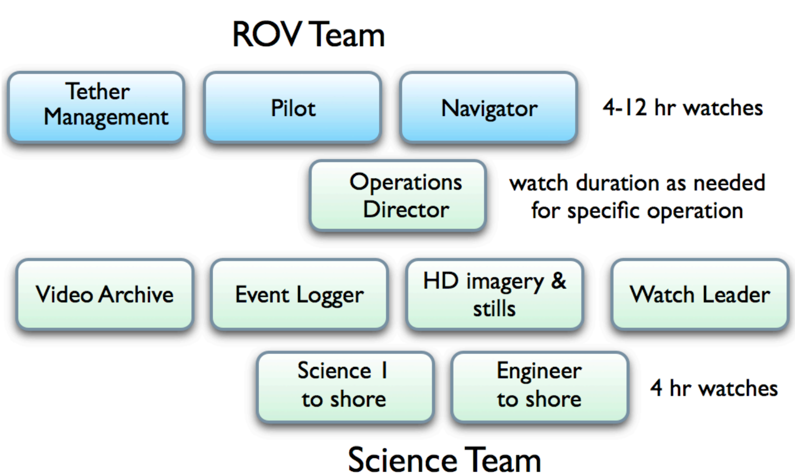


Figure 2. Personnel required during ROV operations.

4.5 Satellite Costs: During O&M cruises there is a requirement for real-time direct communications and video transfer to the Observatory Operations Center. This requirement is driven for the need to be able to complete protocols during power ramp-ups and powering-down of the cable recovery and deployment of secondary infrastructure. There is also a requirement for real-time video links to shore-based personnel who oversee non-COTS MREFC core sensors that will be in place during O&M. Because of berthing constraints it will not be possible to have all non-COTS scientists onboard during all O&M cruises. Bandwidths of at least ~5 mbs off the ship to shore are required during such operations to transfer image, engineering diagrams, environmental data, high quality video, and daily science and engineering operations reports, as well as maintaining voice-over-IP. This bandwidth is based on our MREFC cruise use in 2010 (and anticipated needs in 2011 – see quote **4120-66406**).

4.6 Digital Storage: During the O&M cruises, large volumes of imagery will be acquired with the ROV for documentation of sites pre-recovery, deployment and post deployment in addition to environmental site characterization. Required documentation will include discrete digital still imagery and HD video and frame grabs from the video. Costs associated with digital storage are based on equipment/consumable requirements from the Enlighten'10 cruise. This included storage for 64,000 down-looking digital still images, 137,000 frame grabs from HD video, 147,000 stills from frame grabs with the Virtual Van, 187 hrs of quicktime movies, 194 hrs of MPEG-2 video, 242 hours of SD video, 387 hrs of DVD's and ~16 Tb of HD imagery. These data were recorded on KiPro's, E-Sada drives, external TB drives, and on a Digital Video Archiving system using an automated tape library system. Consumable digital storage for O&M includes KiPro HD recorders with down/cross conversion and 500GB removable cartridges ($3216 ea July 15, 2010) (tape cartridges for the Digital Video Archive ($4290 for 5 media packs: July 20, 2010), and G speed 8TB eSata drives ($1,9999 ea July 15, 2010).

4.7 Calibration and Validation-consumables: To verify that instruments are operational and delivering high quality data, the RSN will conduct "field verification" activities to make independent measurements of the same quantities sensed by deployed instruments. By comparing the shipboard or shore-based analyses with data recorded from the deployed instruments, the accuracy and functionality of the instruments will be assessed. In addition, the data derived from pre-turn field verifications will be used in QA/QC analyses of the drift and post-processing of the data.

4.7.1 Assumptions: The following assumptions were developed to estimate the total cost of the new sampling and shipboard analyses equipment, consumables, and laboratory analyses. Also included in this estimate were the human, ship and ROV resources needed for these efforts.

- One set of verifications prior to end of deployment (pre-turn) and one set of verifications after subsequent deployment (post-turn)
- 3 hours ship time per CTD cast and 1 hour ROV+ship time for any seafloor verification evolution
- Duplicate samples and duplicate casts are needed for reliable verification of water column data
- Duplicate fluid samples for all seafloor vent fluid samples are needed for reliable

verification of seafloor data

- Time sensitive analysis performed shipboard and non-time sensitive analysis will be made on-shore in-house (RSN) or at the UW (Chem-Ocean) if possible
- At sea, undergraduate students will assist in sampling and shipboard analysis, effectively adding two technicians to the shipboard efforts

The following table provides documentation of costs associated with calibration and validation for O&M and these are based on the reference documents:

4120-66390 Metrohm_Dosimat_Titration System
4120-66391 Gas Chromatograph
4120-66392 pH meter
4120-66393 UV-Vis Spectrometer
4120-66394 UW Chemistry Services
4120-66395 UW Pooled Equipment
4120-66396 Camera Calibration Splash Cards
4120-66397 Heavy Lift Winch System
4120-66398 Isobaric Gas Tight Sampler
4120-66403 Mobile Pressure Recorder

4.7.2 Sensor, Verification, Samples and Costs:

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consumable/rental $	recurring TOTAL $	Notes	BOE
ADCPS								
ADCPT								
BOTPT	ROV pressure sensor						Dual MPR, see PREST	See PREST
CAMHD	picture/whitebalance/card	2000					whitebalance, calibration, correction cards 2000	Quote **4120-66396.pdf**: DSC labs for Handy Splash (300), ChromaDuMonde (1100) and White and Warm (200); these will all need T-handles
CAMDS	picture/whitebalance/card	2000					whitebalance, calibration, correction cards 2000	Quote **4120-66396.pdf**: DSC labs for Handy Splash (300), ChromaDuMonde (1100) and White and Warm (200); these will all need T-handles
CTDPF	duplicate water, 10 depths in 200m, 24 depths in full profile; Analysis: salts		14	400	1500	7100	Consum: training 500, btls 500; standards 500; Analysis: $14 salts (UW)	Price list from UW Marine Chemistry, UW Pooled Equipment: **4120-66394.pdf, 4120-66395.pdf**
DOFST/ STA	duplicate water, 10 depths in 200m, 24 depths in full profile; Analysis: DO by winkler titration	25000			1500	1500	Equip: Metrohm O2 titrator 20k, lab setup 5k; Consum: reagents 500, btls 500, standards 500	Quote for Metrohm Titrando Setup: **4120-66390.pdf**, Lab setup from estimate provided by O2 expert Steve Emerson; Consumables from Fischer Scientific

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consumable/rental $	recurring TOTAL $	Notes	BOE
FLOBN/ OTIS								
FLORT	duplicate water, 10 depths in 200m, 24 depths in full profile; Analyses: chla, CDOM		15	400	1300	7300	Equip: our own fluorometer 11k?; Consumables: reagents 200, syringes 200, filters 400, fluorometer rental 500; Analysis: chla onboard; CDOM? 15?	Consumables and fluorometer provided by UW Marine Chemistry as kit: **4120-66394.pdf**
HPIES								
HYDBB								
HYDLF								
MASSP	duplicate Isobaric Gas Tight sample; Analyses: volatiles, H2S, major/minor ions		800	8	250	6650	Equip:GT/IGT (shared); Consumables: sampling containers 250; Analyses: volatiles (onboard, Eric Olson) fluids (onboard, MBARI-Wheat)	Consumables from Fischer Sci include an array of Nalgenes, gas-tight syringes, sulfide gravimetric setup

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consumable/rental $	recurring TOTAL $	Notes	BOE
NUTNR	duplicate water, 10 depths in 200m, 24 depths in full profile; Analyses- Nutrients		20	400	200	8200	Equip: none; Consumables: btls 200; Analysis 20 for all nutrients (UW); shipping considerations if non Seattle	Price list from UW Marine Chemistry, UW Pooled Equipment: **4120-66394.pdf**; Consumables Fischer Scientific
OBSBB								
OBSSP								
OPTAA	rosette AC-s, another method?							
OSMOI	duplicate Isobaric Gas Tight sample; Analyses: major/minor ions, trace		800	0	250	250	Equip:GT/IGT (shared); Consumables: sampling containers 250; Analyses: volatiles (UW-Eric Olson) fluids (onboard, MBARI-Wheat)	Consumables from Fischer Sci include an array of Nalgenes, gas-tight syringes, sulfide gravimetric setup
PARAD	rosette PAR, another method?							

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consum able/re ntal $	recurring TOTAL $	Notes	BOE
PCO2W	triplicate water, 10 depths in 200m, 24 depths in full profile; Analysis: alkalinity	25000		400	1500	1500	Equip: Alkalinity Dosimat titrator 20k, lab setup 5k; Consumables: acid standardization 500, btls 500, reagents 500; Analysis inhouse at UW	Quote for Metrohm Dosmiat Setup: **4120-66390.pdf**, pH to be measured onboard, but included in PHSEN line item: Quote **4120-66393.pdf**, Lab setup from estimate provided by CO2 expert Chris Sabine; Consumablesand reagents from Fischer Scientific; Acid standards calibrated in Andrew Dixon laboratory UCSD
PHSEN	triplicate water, 10 depths in 200m, 24 depths in full profile; Analysis: pH	25000			1500	1500	Equip: spectrophotometer for pH 20k, lab setup 5k; Consumables: standards 500, btls 500, reagents 500; Analysis shipboard	Quote for UV-Vis Agilent 8453 Spectrometer for pH : **4120-66393.pdf**; Samples to be directly loaded into cuvettes (125 each, need 30)
PPSDN	duplicate Isobaric Gas Tight sample; Analyses: filter for micro, 16s		100	4	500	900	Equip:GT/IGT (shared); Consumables: sampling containers 500; Analyses:16s rRNA	16s rRNA analysis ~20/sample, however first pass analysis to distill data brings cost to 100/sample; Consumables include sterile equipment and sample containers from Fishcer Sci

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consum able/re ntal $	recurring TOTAL $	Notes	BOE
PREST	ROV pressure sensor	30000				2000	Equip: Mobil Pressure Recorder=2 x Paroscientific 410K transudcers, pressure case, electronics, ROV connections; Recurring cost: pre-cruise calibration	Cost of dual Mobil Pressure Recorder based on estimate by expert Bill Chadwick (OSU/PMEL) and Scott Nooner (LDEO) Quote: **4120-66403.pdf**; Pre-cruise calibration of MPRs based on estimate by expert Bill Chadwick
RASFL	Isobaric Gas Tight sample; Analyses: major/minor ions, trace		800	0	250	250	Equip:GT/IGT (shared); Consumables: sampling containers 250; Analyses: volatiles (UW-Eric Olson) fluids (MBARI-Wheat)	Consumables from Fischer Sci include an array of Nalgenes, gas-tight syringes, sulfide gravimetric setup
SPKIR	rosette SPIKR?							

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consum able/re ntal $	recurring TOTAL $	Notes	BOE
THSPH	Isobaric Gas Tight sample; ROV temperature probe; Analyses: pH, H2S (gravimetric), H2 and volatiles shipboard; Major/minor ions, trace shoreside	112000	800	4	1000	4200	Equipment: GT/IGT (x2=two and one spare) 75000, HPLC pump 3000, pH meter 3000, gravimetric H2S setup 1000, GC 30000; consumables: carrier gas, pH electrode, sampling containers;	IGT: 25000/unit x3 (two samplers+spare= 3 total) based on estimate from expert Jeffery Seewald **4120-66398.pdf**, currently the PI associated with these samplers (developed on NSF funding); HPLC pump is a high pressure pump that maintains backpressure on the gas-tight sampler while extracting samples on board the ship, this is an estimated price based on a quick survey of offerings on several websites; GC: quote from SRI and Quadrex for ~20k: **4120-66391.pdf**, 4x Valco valving, Valco and swagelok plumbing, spare parts, toolkit 10k; pH meter Fischer quote **4120-66392.pdf** 2400+ 2 electrodes @300; H2S setup is a filter rig, Chem-Glass glassware;
TMPSF	ROV temperature probe						ROV must be equipped with temperature probe	

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consumable/rental $	recurring TOTAL $	Notes	BOE
TRHPH	Isobaric Gas Tight sample; ROV temperature probe; Analyses: pH, H2S (gravimetric), H2 shipboard; Major/minor ions, trace shoreside		800	0	250	250	Equip:GT/IGT (shared); Consumables: sampling containers 250; Analyses: volatiles (UW-Eric Olson) fluids (MBARI-Wheat)	Consumables from Fischer Sci include an array of Nalgenes, gas-tight syringes, sulfide gravimetric setup
VADCP								
VEL3D								
ZPLKS	tungsten beads; MOCNESS ideal, but not feasible	10000					MOCNESS-not feasible (20+ hours shiptime, 2 techs, cost, deck space for van; shift to PI study); Calibration is via a frame enbedded with three different sized tungsten beads	Tungsten carbide beads with 6% cobalt, sized 38.1 40.0 43.0 mm diameter, enmeshed in seine woven in monofilament line; frame must be manipulated with ROV.

Name	Field Verification/ Method	new equip ($)	lab (cost/ smpl)	# samples	consum able/re ntal $	recurring TOTAL $	Notes	BOE
		Equipment total				*Total consuma ble*		
		2310 00			*total*	*41600*		
		split 2012/2013			*seaflo or axial*	*9050*		
					seaflo or hydrat e	*3450*		
					wc axial	14550		
					wc hydrat e	14550		
					consumables 10000			

4140-64542 O&M BOE Document Number Index RSN

	5/4/2011	Ver 1-00
Document Number	**Name**	**Owner**
4140-54543	OM_WBS_Dictionary_BOE_Index_RSN (xls)	Ittig
4140-64544	OM_Operations_BOE_RSN (doc)	Ittig
4140-65979	OM_Data_Managment_BOE_RSN (doc)	Orest
4140-65980	OM_Sustaining_Engineering_BOE_RSN (doc)	Denny/Harkins
4140-65981	OM_Transmission_Facilities_BOE_RSN (doc)	Ittig
4140-65982	OM_Primary_Infrastructure_BOE_RSN (doc)	Ittig
4140-65983	OM_Secondary_Infrastructure_Instruments_BOE_RSN (doc)	Harrington
4140-65984	OM_Secondary_Infrastructure_Cables_BOE_RSN (doc)	Harrington
4140-65985	OM_Secondary_Infrastructure_Nodes_BOE_RSN (doc)	Harrington
4140-65986	OM_Secondary_Infrastructure_Vertical_Moorings_BOE_RSN (doc)	Harrington
4140-65987	OM_Primary_Infrastructure_Spares (doc)	Ittig
4140-65988	OM_Maintenance_Cruises_BOE_RSN (doc)	Kelley/Giora
4314-00001	OM_Secondary_Spares_Plan_RSN (doc)	Harrington
4308-00005	Sensor_Maintenance_Plan_RSN (doc)	Kelley/Denny
4140-00016	LVNode Unit BOE (xls)	Harrington
4140-00018	Cable BOE (xls)	Harrington
4140-00019	Connectors BOE (xls)	Harrington
4140-00020	CTA BOE (xls)	Harrington
4140-00021	HD Interface Box BOE (xls)	Harrington
4140-00022	Instrument Unit BOE (xls)	Harrington
4140-65989	Vertical Mooring Spares BOE(xls)	Harrington
4140-00024	Historical Cable Quotes (Hardcopy Only)	Harrington
4140-00025	Instrument Inteface Box Cost (xls)	Harrington
4140-00013	Medium Power Jbox Unit BOE (xls)	Harrington
4140-00014	Low Power Jbox Unit BOE(xls)	Harrington
4140-00011	Aloha Mooring Replication Costs (doc)	APL+OE
4140-00012	Aloha Mooring Replication Costs (xls)	APL+OE
4140-64538	Deep Profiler Spares BOE (xls)	Harrington
4140-64539	Shallow Profiler Spares BOE (xls)	Harrington
4140-66399	Instrument Module VM Spares BOE (xls)	Harrington
4315-66407	PN1A Mooring Deployment (doc)	Kelley
4315-00001	Hydrate_Installation_Scenario_RSN	Harrington

4120-64541 O&M Quote Doc Number Index RSN

	5/4/2011	ver 1-00	
Quote Number	**Name**	**Owner**	**Notes**
4120-00001	ODI Connectors	Harrington	
4120-00002	ODI Connectors	Harrington	
4120-00003	Secondary Cables	Harrington	
4120-00004	Dry Mate Connectors	Harrington	
4120-00005	Lambda Power Supply	Harrington	
4120-00006	Network Switch	Harrington	
4120-00007	Digi Ports	Harrington	
4120-00008	PC104 Controller	Harrington	
4120-00009	DC Power Supplies	Harrington	
4120-00010	DC Power Switches	Harrington	
4120-00012	Pressure Housings	Harrington	
4120-00030	RAS	SD	RASFL
4120-00031	PPS	SD	PPSDN
4120-00032	BB Hydrophone	SD	HYDBB
4120-00033	Digital Still Camera	SD	CAMDS
4120-00034	CTD	SD	CTDPF
4120-00035	DO	SD	DOSTA
4120-00036	pH	SD	PHSEN
4120-00037	PAR	SD	PARAD
4120-00038	ACM	SD	SPKIR
4120-00039	ISUS Nitrate	SD	NUTNR
4120-00040	ADCP	SD	ADCPS,ADCPT
4120-00041	Tilt	SD	BOTPT
4120-00042	Pressure	SD	PREST
4120-00043	HD Camera	SD	CAMHD
4120-00044	sht per seis	SD	OBSSP,OBSSK
4120-00047	BB Seismometer	SD	OBSBB,OBSBK
4120-00048	Fluorometer - bb2f	SD	FLORD
4120-00049	Fluorometer - 3W	SD	FLORT
4120-00050	HPIES	SD	HPIES
4120-00051	pCO2 in water	SD	PCO2W
4120-00052	5-Bm ADCP	SD	VADCP
4120-00053	MAVS-3	SD	VEL3D
4120-00054	Acoustic. Modem	SD	ACOMM
4120-00055	Mass Spectrometer	SD	MASSP
4120-00056	Optical Attenuation	SD	OPTAA
4120-00057	OSMO	SD	OSMOI
4120-00058	OTIS	SD	OTISF
4120-00059	T_H2_H2S_Ph	SD	THSPH
4120-00060	Temp_seafloor	SD	TMPSF
4120-00061	Temp_Resistivity	SD	TRHPH
4120-66390	Metrohm Dosimat Titration System	GP	
4120-66391	Gas Chromatograph	GP	
4120-66392	pH meter	GP	
4120-66393	UV-Vis Spectrometer	GP	
4120-66394	UW Chemistry Services	GP	
4120-66395	UW Pooled Equipment	GP	
4120-66396	Camera Calibration Splash Cards	GP	
4120-66397	Heavy Lift Winch System	GP	
4120-66398	Isobaric Gas Tight Sampler	GP	
4120-66400	McLane Mooring Profiler	TM	
4120-66401	Acoustic Releases	TM	
4120-66402	Underwater Slip Ring Assembly	TM	
4120-66403	Mobile Pressure Recorder	GP	
4120-66404	ROV Services Quote	DK	
4120-66405	ROV Services Quote	DK	
4120-66406	Satellite Services	DK	

WBS Item	WBS Type	WBS Title	WBS Definition
2.4	S	Regional Scale Observatory	This summary account captures all of the O&M work assigned to the RSN Implementing Organization.
2.4.1	S	Initial Operations & Maintenance (CLIN 006)	This summary account includes all resources to prepare for and fulfill RSN Operations and Maintenance (O&M) activities. O&M activities include Operatio Management Center staffing and coordination to operate the installed equipment including monitoring and configuring the equipment; Data Product Man to analyze data from the system; Field Operations planning and conduct to install and retrieve equipment; Equipment Management to maintain and refurb equipment; Sustaining Engineering to resolve system and equipment failures and address design issues associated with long term operation of the equipm
2.4.1.2	S	OM Year 2 (2011)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 2 (2011). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.2.1	C	Operations	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, Hea Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 2 (2011).
2.4.1.2.1.0	W	SPA - OM Year 2 (2011) Operations	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Operations through 4/30/2011.
2.4.1.2.1.20	W	MATL - Operations - 2011	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Cal Year 2 (2011)
2.4.1.2.1.21	W	TRVL - Operations - 2011	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2011)
2.4.1.2.1.22	W	SUBS - Operations - 2011	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 2 (2011)
2.4.1.2.1.23	W	EQUP - Operations - 2011	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M C Year 2 (2011)
2.4.1.2.1.24	W	Project Controls/Finance - 2011	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance projec O&M Calendar Year 2 (2011). The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsibi Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also c the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.2.1.25	W	Documentation 2011	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 2 (2011).
2.4.1.2.1.26	W	Environmental Health and Safety - 2011	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S) for O&M Calendar Year 2 (2011). Management of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.2.1.27	W	QA/QC Inspections - 2011	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN. Management of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained during all aspects of th program.
2.4.1.2.1.28	W	Monitoring and Surveillance - Assurance - 2011	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 2 (2011).
2.4.1.2.1.29	W	Network Planning & Maintenance - Fulfillment - 2011	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.2.1.30	W	Data Management - 2011	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 2 (2011).
2.4.1.2.1.31	W	Maintenance Cruise Planning - 2011	This work package captures the level of effort for labor associated with the management and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastructure for the RSN; and development of the Field Operation Handbooks.
2.4.1.2.2	C	Sustaining Engineering - 2011	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 2 (2011).
2.4.1.2.2.0	W	SPA - OM Year 2 (2011) Sustaining Engineering	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Sustaining Operations through 4/30/2011.
2.4.1.2.2.20	W	MATL - Sustaining Engineering - 2011	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 2 (2011).
2.4.1.2.2.21	W	TRVL - Sustaining Engineering - 2011	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 2 (2011).
2.4.1.2.2.22	W	SUBS - Sustaining Engineering - 2011	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 2 (2011).
2.4.1.2.2.23	W	EQUP - Sustaining Engineering - 2011	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for (Calendar Year 2 (2011).
2.4.1.2.2.24	W	Engineering Oversight / Support - 2011	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M I the project for O&M Calendar Year 2 (2011). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.2.2.25	W	APL Technical Support Center - 2011	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and p support for the RSN.
2.4.1.2.3	C	Education and Public Engagement - 2011	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories a public for the RSN for O&M Calendar Year 2 (2011).
2.4.1.2.3.0	W	SPA - OM Year 2 (2011) Education and Public Engagement	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Education and Public Engagements through 4/30/2011.
2.4.1.2.3.20	W	Community Interest and Information - 2011	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 2 (2011).
2.4.1.2.3.21	W	Other Observatories - 2011	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 2 (201
2.4.1.2.3.22	W	Communication and Outreach - 2011	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2011)
2.4.1.2.4	C	Transmission Facilities - 2011	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to sup ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 2 (2011). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.2.4.0	W	SPA - OM Year 2 (2011) Transmission Facilities	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Transmission Facilities through 4/30/2011.
2.4.1.2.4.20	W	MATL - Transmission Facilities - 2011	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Mai phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.4.21	W	TRVL - Transmission Facilities - 2011	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.4.22	W	SUBS - Transmission Facilities - 2011	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Station; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.2.4.23	W	EQUP - Transmission Facilities - 2011	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.4.24	W	Portland Oregon CyberPoP - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance of the leased space in the Pittock Bu Portland, OR for O&M Calendar Year 2 (2011). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.2.4.25	W	Pacific City Oregon Shore Facility - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance of the 4,000 sq ft of space at the Pac OR Shore Station; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 2 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.2.4.26	W	Logistics/Maintenance Facility, Oregon - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance of a logistics and maintenance facilit Oregon coast for O&M Calendar Year 2 (2011). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.2.4.27	W	Logistics/Maintenance Facility - Washington - 2011	This work package captures the level of effort for labor associated with the management, oversight, and maintenance with of a logistics and maintenance f Washington for O&M Calendar Year 2 (2011). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.2.5	C	Backhaul - DEPRECATED - 2011	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.
2.4.1.2.5.0	W	SPA - OM Year 2 (2011) Backhaul	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Backhaul through 4/30/2011.
2.4.1.2.6	C	Primary Infrastructure - 2011	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, anc America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 2 (2011).
2.4.1.2.6.0	W	SPA - OM Year 2 (2011) Primary Infrastructure	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Primary Infrastructure through 4/30/2011.
2.4.1.2.6.20	W	MATL - Primary Infrastructure - 2011	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.21	W	TRVL - Primary Infrastructure - 2011	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.22	W	SUBS - Primary Infrastructure - 2011	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.2.6.23	W	EQUP - Primary Infrastructure - 2011	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 2 (2011).
2.4.1.2.6.24	W	Regulatory Compliance - 2011 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 2 (20 large component of this will be support of the Oregon Fishermen's Cable Committee.
2.4.1.2.6.25	W	Wet Plant Maintenance - 2011 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 2 (2011), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.2.6.26	W	Wet Plant Spares - 2011 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 2 (2011).
2.4.1.2.7	C	Secondary Infrastructure - 2011	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infra composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 2 (2011).
2.4.1.2.7.0	W	SPA - OM Year 2 (2011) Secondary Infrastructure	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Secondary Infrastructure through 4/30/2011.
2.4.1.2.7.20	W	Spares - 2011 Secondary Infrastructure	This work package captures the labor associated with the acquisition of RSN spare secondary infrastructure including cables, components, and sensors for Calendar Year 2 (2011).
2.4.1.3	S	OM Year 3 (2012)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 3 (2012). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.3.1	C	Operations - 2012	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, He Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 3 (2012).
2.4.1.3.1.20	W	MATL - Operations - 2012	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Ca Year 3 (2012).
2.4.1.3.1.21	W	TRVL - Operations - 2012	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2012).
2.4.1.3.1.22	W	SUBS - Operations - 2012	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 3 (2012).
2.4.1.3.1.23	W	EQUP - Operations - 2012	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M C Year 3 (2012).
2.4.1.3.1.23.1	S	EQUP - Winch - 2012	This summary account captures the equipment associated with the acquisition of a winch for the maintenance and installation of the RSN secondary infras
2.4.1.3.1.23.2	S	EQUP - Analyzers - 2012	This summary account captures the equipment associated with the acquisition of a Metrohm O2 Titrator, Alkalinity Dosimat Titrator, PH Spectrophotomet Pressure Recorder, and MOCNESS for the maintenance of the RSN secondary infrastructure.
2.4.1.3.1.23.3	S	EQUP - Shipping Container - 2012	This summary account captures the equipment associated with the acquisition of a 10' ISO shipping container with work benches and shelving for the mai of the RSN secondary infrastructure.
2.4.1.3.1.24	W	Project Controls/Finance - 2012	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance projec O&M Calendar Year 3 (2012).. The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsib Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also c the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.3.1.25	W	Documentation 2012	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 3 (2012).
2.4.1.3.1.26	W	Environmental Health and Safety - 2012	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S for O&M Calendar Year 3 (2012). Managment of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.3.1.27	W	QA/QC Inspections - 2012	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN for Calendar Year 3 (2012). Managment of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained aspects of the program.
2.4.1.3.1.28	W	Monitoring and Surveillance - Assurance - 2012	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 3 (2012).
2.4.1.3.1.29	W	Network Planning & Maintenance - Fulfillment - 2012	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.3.1.30	W	Data Management - 2012	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 3 (2012).
2.4.1.3.1.31	W	Maintenance Cruise Planning - 2012	This work package captures the level of effort for labor associated with the managmenet and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastrcuture for the RSN; and development of the Field Operation Handbooks.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.3.2	C	Sustaining Engineering - 2012	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 3 (2012).
2.4.1.3.2.20	W	MATL - Sustaining Engineering - 2012	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 3 (2012).
2.4.1.3.2.21	W	TRVL - Sustaining Engineering - 2012	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 3 (2012).
2.4.1.3.2.22	W	SUBS - Sustaining Engineering - 2012	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 3 (2012).
2.4.1.3.2.23	W	EQUP - Sustaining Engineering - 2012	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for (Calendar Year 3 (2012).
2.4.1.3.2.24	W	Engineering Oversight / Support - 2012	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M I the project for O&M Calendar Year 3 (2012). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.
2.4.1.3.2.25	W	APL Technical Support Center - 2012	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and p support for the RSN.
2.4.1.3.3	C	Education and Public Engagement - 2012	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories a public for the RSN for O&M Calendar Year 3 (2012).
2.4.1.3.3.20	W	Community Interest and Information - 2012	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 3 (2012).
2.4.1.3.3.21	W	Other Observatories - 2012	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 3 (201
2.4.1.3.3.22	W	Communication and Outreach - 2012	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2012).
2.4.1.3.4	C	Transmission Facilities - 2012	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to sup ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 3 (2012). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.3.4.20	W	MATL - Transmission Facilities - 2012	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Mai phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.4.21	W	TRVL - Transmission Facilities - 2012	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.4.22	W	SUBS - Transmission Facilities - 2012	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 3 (2012). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Staion; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.3.4.23	W	EQUP - Transmission Facilities - 2012	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.4.24	W	Portland Oregon CyberPoP - 2012	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the leased space in the Pittock Buil Portland, OR for O&M Calendar Year 3 (2012). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.3.4.25	W	Pacific City Oregon Shore Facility - 2012	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the 4,000 sq ft of space at the Pacif OR Shore Staion; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 3 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.3.4.26	W	Logistics/Maintenance Facility, Oregon - 2012	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of a logistics and maintenance facility Oregon coast for O&M Calendar Year 3 (2012). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.3.4.27	W	Logistics/Maintenance Facility - Washington - 2012	This work package captures the level of effort for labor associated with the managment, oversight, and maintenancewith of a logistics and maintenance fa Washington for O&M Calendar Year 3 (2012). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.3.5	C	Backhaul - 2012 DEPRECATED	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.
2.4.1.3.6	C	Primary Infrastructure - 2012	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, anc America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 3 (2012).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.3.6.20	W	MATL - Primary Infrastructure - 2012	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.6.21	W	TRVL - Primary Infrastructure - 2012	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.6.22	W	SUBS - Primary Infrastructure - 2012	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.6.23	W	EQUP - Primary Infrastructure - 2012	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 3 (2012).
2.4.1.3.6.24	W	Regulatory Compliance - 2012 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 3 (20 large compnent of this will be support of the Oregon Fishermens Cable Committee.
2.4.1.3.6.25	W	Wet Plant Maintenance - 2012 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 3 (2012), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.3.6.26	W	Wet Plant Spares - 2012 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 3 (2012).
2.4.1.3.7	C	Secondary Infrastructure - 2012	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infra composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 3 (2012).
2.4.1.3.7.20	W	MATL - Secondary Infrastructure - 2012	This work package captures the material associated with the acquisition of RSN spare secondary infrastructure including cables, components, and sensors Calendar Year 3 (2012).
2.4.1.3.7.21	W	EQUIP - Spares 2012 Secondary Infrasture	This work package captures the equipment associated with the acquisition spare J-box, instruments, and extension cables.
2.4.1.3.7.21.1	S	EQUP - J Box Spares 2012	This summary account captures the equipment associated with the acquisition of spare J-Boxes.
2.4.1.3.7.21.1.1	S	EQUP - UW_APL_NODE_Interface Box BB Seis	This summary account captures the equipment associated with the acquisition of spare Interface Box Broadband Seismometer including titanium housing, and ROV connectors.
2.4.1.3.7.21.1.2	S	EQUP - UW_APL_NODE_Interface Box Camera	This summary account captures the equipment associated with the acquisition of spare Interface Box Camera including titanium housing, frame, and ROV connectors.
2.4.1.3.7.21.1.3	S	EQUP - UW_APL_NODE_Interface Box HD Camera	This summary account captures the equipment associated with the acquisition of spare Interface Box HD Camera including titanium housing, frame, and R connectors.
2.4.1.3.7.21.1.4	S	EQUP - UW_APL_NODE_Interface Box Mas Spec	This summary account captures the equipment associated with the acquisition of spare Interface Box Mass Spectrometer including titanium housing, fram ROV connectors.
2.4.1.3.7.21.1.5	S	EQUP - UW_APL_NODE_HPIES	This summary account captures the equipment associated with the acquisition of spare HPIES including titanium housing, frame, and ROV connectors.
2.4.1.3.7.21.1.6	S	EQUP - UW_APL_NODE_Interface Box OSMO	This summary account captures the equipment associated with the acquisition of spare Interface Box Osmotic Sampler including titanium housing, frame, connectors.
2.4.1.3.7.21.1.7	S	EQUP - UW_APL_NODE_Interface Box PPS RAS	This summary account captures the equipment associated with the acquisition of spare Interface Box PPS RAS including titanium housing, frame, and ROV connectors.
2.4.1.3.7.21.1.8	S	EQUP - UW_APL_NODE_Interface Box Tilt	This summary account captures the equipment associated with the acquisition of spare Interface Box Tilt including titanium housing, frame, and ROV conn
2.4.1.3.7.21.1.9	S	EQUP - UW_APL_NODE_Interface Thermister Array	This summary account captures the equipment associated with the acquisition of spare Interface Thermister Array including titanium housing, frame, and connectors.
2.4.1.3.7.21.1.10	S	EQUP - UW_APL_NODE_Interface THSPH	This summary account captures the equipment associated with the acquisition of spare Interface THSPH including titanium housing, frame, and ROV conne
2.4.1.3.7.21.1.11	S	EQUP - UW_APL_NODE_Interface TRHPH	This summary account captures the equipment associated with the acquisition of spare Interface TRHPH including titanium housing, frame, and ROV conne
2.4.1.3.7.21.1.12	S	EQUP - UW_APL_NODE_Interface Vel3D	This summary account captures the equipment associated with the acquisition of spare Interface Box 3-D Acoustic Current Meter including titanium housi and ROV connectors.
2.4.1.3.7.21.1.13	S	EQUP - UW_APL_NODE_Interface Box Short Period	This summary account captures the equipment associated with the acquisition of spare Interface Box Short Period including titanium housing, frame, and connectors.
2.4.1.3.7.21.1.14	S	EQUP - UW_APL_NODE_LP Jbox Endur 80m	This summary account captures the equipment associated with the acquisition of spare Low Power J-box Endurance 80m including titanium housing, fram ROV connectors.
2.4.1.3.7.21.1.15	S	EQUP - UW_APL_NODE_LP JBox Mooring	This summary account captures the equipment associated with the acquisition of spare Low Power J-Box Mooring including titanium housing, frame, and connectors.
2.4.1.3.7.21.1.16	S	EQUP - UW_APL_NODE_LP JBox Sourthern Hyd	This summary account captures the equipment associated with the acquisition of spare Low Power L-Box Southern hydrate including titanium housing, fra ROV connectors.
2.4.1.3.7.21.1.17	S	EQUP - UW_APL_NODE_MP JBox Ashes	This summary account captures the equipment associated with the acquisition of spare Medium Power J-Box Ashes including titanium housing, frame, anc connectors.
2.4.1.3.7.21.1.18	S	EQUP - LV Node Std	This summary account captures the equipment associated with the acquisition of spare Low Voltage Node Standard including titanium housing, frame, anc connectors.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.3.7.21.2	S	EQUIP - Instruments Spares 2012	This summary account captures the equipment associated with the acquisition of spare instruments including ADCPT, ADCPS, BOTPT, CAMHD, CAMDS, OT HYDLF, MASSP, OBSBB, OBSSP, PREST, TMPSF, and VEL3D.
2.4.1.3.7.21.3	S	EQUP - Extension Cables - Spares 2012	This summary account captures the equipment associated with the acquisition of spare extension cables including armored seafloor cable, HP seafloor cab EO Wetmate Connectos, Cable Termination Assemblies, and ROV Wetmate Connectors.
2.4.1.3.7.22	W	Secondary Nodes Spares 2012	This work package captures the labor associated with the acquisition of RSN spare secondary infrastructure including cables, components, and sensors for Calendar Year 3 (2012).
2.4.1.3.7.22.1	S	Procure Components Secondary Nodes Spares 2012	This summary account captures the labor associated with the acquisition of spare secondary node spares including cables, components, and sensors for O Calendar Year 3 (2012).
2.4.1.3.7.22.2	S	Final Assembly and Test Secondary Nodes Spares 2012	This summary account captures the labor associated with the assembly and testing of spare secondary node spares including cables, components, and sen O&M Calendar Year 3 (2012).
2.4.1.3.7.22.2.1	S	Assembly and Test Secondary Nodes Spares 2012 UW_APL_NODE_Inte	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box Broadband Seismometer.
2.4.1.3.7.22.2.2	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_Interface Box (	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box Camera.
2.4.1.3.7.22.2.3	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_Interface Box I	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box HD Camera.
2.4.1.3.7.22.2.4	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_Interface Box I	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box Mass Spectrometer.
2.4.1.3.7.22.2.5	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_Interface Box I	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box HPIES.
2.4.1.3.7.22.2.6	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_Interface Box (	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box OSMO.
2.4.1.3.7.22.2.7	S	Assembly and Test J Box - Axial UW_APL_NODE_Interface Box PPS RAS	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box PPS RAS.
2.4.1.3.7.22.2.8	S	Assembly and Test J Box - Axial UW_APL_NODE_Interface Box Tilt	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box Tilt
2.4.1.3.7.22.2.9	S	Assembly and Test J Box - Axial UW_APL_NODE_Interface Thermister A	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Thermister Array.
2.4.1.3.7.22.2.10	S	Assembly and Test J Box - Axial UW_APL_NODE_Interface THSPH	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface THSPH.
2.4.1.3.7.22.2.11	S	Assembly and Test J Box - Axial UW_APL_NODE_Interface TRHPH	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface TRHPH.
2.4.1.3.7.22.2.12	S	Assembly and Test J Box - Axial UW_APL_NODE_Interface Vel3D	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Vel3D.
2.4.1.3.7.22.2.13	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_Interface Box S	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Interface Box Short Period
2.4.1.3.7.22.2.14	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_LP Jbox Endur	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Low Power J-Box Endurance 80m.
2.4.1.3.7.22.2.15	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_LP JBox Moori	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Low Power J-Box Mooring.
2.4.1.3.7.22.2.16	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_LP JBox Sourth	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Low Power J-Box Sourthern Hydrate.
2.4.1.3.7.22.2.17	S	Assembly and Test J Box Hydrate Ridge UW_APL_NODE_MP Jbox Ashes	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Medium Power J-box Ashes.
2.4.1.3.7.22.2.18	S	Assembly and Test LVNode Std Spares 2012	This summary account captures the labor associated with the assembly and testing of spare secondary node spare Low Voltage Node Standard.
2.4.1.3.7.23	W	Instrurments Spares 2012	This work package captures the labor associated with the acquisition, inspection and testing of RSN spare instruments for O&M Calendar Year 3 (2012).
2.4.1.3.7.23.1	S	Procure Sensors Spares 2012	This summary account captures the labor associated with the procurment of spare instruments for O&M Calendar Year 3 (2012).
2.4.1.3.7.23.2	S	Inpection and Test Sensors Bottom, Axial	This summary account captures the labor associated with the inspection and test of spare instruments for O&M Calendar Year 3 (2012).
2.4.1.3.7.24	W	Extension Cables Spares 2012	This work package captures the labor associated with the acquisition of RSN spare extension cables for O&M Calendar Year 3 (2012).
2.4.1.3.7.24.1	S	Procure Components Extension Cables -Spares 2012	This summary account captures the labor associated with the procurement of spare extension cables for O&M Calendar Year 3 (2012) including ROV Optica Connectors, ROV Electrical Connectors, Seafloor Cable, and Armored seafloor Cable.
2.4.1.4 S		OM Year 4 (2013)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 4 (2013). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.4.1 C		Operations - 2013	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, Hea Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 4 (2013).
2.4.1.4.1.20 W		MATL - Operations - 2013	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Cal Year 4 (2013).
2.4.1.4.1.21 W		TRVL - Operations - 2013	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2013).
2.4.1.4.1.22 W		SUBS - Operations - 2013	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 4 (2013).
2.4.1.4.1.23 W		EQUP - Operations - 2013	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M C Year 4 (2013).
2.4.1.4.1.23.1 S		EQUP - Analyzers - 2013	This summary account captures the equipment associated with the acquisition of a Metrohm O2 Titrator, Alkalinity Dosimat Titrator, PH Spectrophotomet Pressure Recorder, and MOCNESS for the maintenance of the RSN secondary infrastructure.
2.4.1.4.1.23.2 S		EQUP - Shipping Container - 2013	This summary account captures the equipment associated with the acquisition of a 10' ISO shipping container with work benches and shelving for the mair of the RSN secondary infrastructure.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.4.1.24	W	Project Controls/Finance - 2013	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance projec O&M Calendar Year 4 (20132). The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsib the Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also c the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.4.1.25	W	Documentation 2013	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 4 (20132).
2.4.1.4.1.26	W	Environmental Health and Safety - 2013	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S for O&M Calendar Year 4 (2013). Managment of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.4.1.27	W	QA/QC Inspections - 2013	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN for Calendar Year 4 (2013). Managment of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained aspects of the program.
2.4.1.4.1.28	W	Monitoring and Surveillance - Assurance - 2013	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 4 (2013).
2.4.1.4.1.29	W	Network Planning & Maintenance - Fulfillment - 2013	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.4.1.30	W	Data Management - 2013	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 4 (2013).
2.4.1.4.1.31	W	Maintenance Cruise Planning - 2013	This work package captures the level of effort for labor associated with the managmenet and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastrcuture for the RSN; and development of the Field Operation Handbooks.
2.4.1.4.2	C	Sustaining Engineering - 2013	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 4 (2013).
2.4.1.4.2.20	W	MATL - Sustaining Engineering - 2013	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 4 (2013).
2.4.1.4.2.21	W	TRVL - Sustaining Engineering - 2013	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 4 (2013).
2.4.1.4.2.22	W	SUBS - Sustaining Engineering - 2013	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 4 (2013).
2.4.1.4.2.23	W	EQUP - Sustaining Engineering - 2013	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for (Calendar Year 4 (2013).
2.4.1.4.2.24	W	Engineering Oversight / Support - 2013	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M I the project for O&M Calendar Year 4 (2013). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.
2.4.1.4.2.25	W	APL Technical Support Center - 2013	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and p support for the RSN.
2.4.1.4.3	C	Education and Public Engagement - 2013	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories a public for the RSN for O&M Calendar Year 4 (2013).
2.4.1.4.3.20	W	Community Interest and Information - 2013	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 4 (2013).
2.4.1.4.3.21	W	Other Observatories - 2013	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 4 (201
2.4.1.4.3.22	W	Communication and Outreach - 2013	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2013).
2.4.1.4.4	C	Transmission Facilities - 2013	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to supp ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 4 (2013). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.4.4.20	W	MATL - Transmission Facilities - 2013	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Mai phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.4.21	W	TRVL - Transmission Facilities - 2013	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.4.22	W	SUBS - Transmission Facilities - 2013	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 4 (2013). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Staion; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.4.4.23	W	EQUP - Transmission Facilities - 2013	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.4.24	W	Portland Oregon CyberPoP - 2013	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the leased space in the Pittock Buil Portland, OR for O&M Calendar Year 4 (2013). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.4.4.25	W	Pacific City Oregon Shore Facility - 2013	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the 4,000 sq ft of space at the Pacif OR Shore Staion; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 4 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.4.4.26	W	Logistics/Maintenance Facility, Oregon - 2013	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of a logistics and maintenance facility Oregon coast for O&M Calendar Year 4 (2013). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.4.4.27	W	Logistics/Maintenance Facility - Washington - 2013	This work package captures the level of effort for labor associated with the managment, oversight, and maintenancewith of a logistics and maintenance fa Washington for O&M Calendar Year 4 (2013). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.4.5	C	Backhaul - 2013 DEPRECATED	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.
2.4.1.4.6	C	Primary Infrastructure - 2013	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, and America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 4 (2013).
2.4.1.4.6.20	W	MATL - Primary Infrastructure - 2013	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.6.21	W	TRVL - Primary Infrastructure - 2013	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.6.22	W	SUBS - Primary Infrastructure - 2013	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.6.23	W	EQUP - Primary Infrastructure - 2013	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 4 (2013).
2.4.1.4.6.24	W	Regulatory Compliance - 2013 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 4 (20 large compnent of this will be support of the Oregon Fishermens Cable Committee.
2.4.1.4.6.25	W	Wet Plant Maintenance - 2013 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 4 (2013), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.4.6.26	W	Wet Plant Spares - 2013 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 4 (2013).
2.4.1.4.7	C	Secondary Infrastructure - 2013	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infras composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 4 (2013).
2.4.1.4.7.20	W	MATL - Secondary Infrastructure - 2013	This work package captures the material associated with the acquisition of RSN spare secondary infrastructure including cables, components, and sensors Calendar Year 4 (2013).
2.4.1.4.7.21	W	EQUIP - Spares 2013 Secondary Infrasture	This work package captures the equipment associated with the acquisition spare J-box, instruments, and extension cables.
2.4.1.4.7.21.1	S	EQUP - Secondary Node Spares 2013	This summary account captures the equipment associated with the acquisition of spare J-Boxes.
2.4.1.4.7.21.1.1	S	EQUP - UW_APL_NODE_MP JBox Common	This summary account captures the equipment associated with the acquisition of spare Medium Power J-Box Common including titanium housing, frame, connectors.
2.4.1.4.7.21.1.2	S	EQUP - UW_APL_NODE_MP JBox Summit Hydrate	This summary account captures the equipment associated with the acquisition of spare Medium Power J-Box Summit Hydrate including titanium housing, and ROV connectors.
2.4.1.4.7.21.2	S	EQUP - Vertical Mooring + Profilers Spares 2013	This summary account captures the equipment associated with the acquisition of spares for the Vertical Mooring Controller and Shallow Profiler
2.4.1.4.7.21.2.1	S	EQUP - UW_APL_NODE_Mooring Controller Spares 2013	This summary account captures the equipment associated with the acquisition of spare Vertical Mooring Controller including titanium housing, ROV Conne and frame.
2.4.1.4.7.21.2.2	S	EQUP - Shallow Profiler Spares 2013	This summary account captures the equipment associated with the acquisition of Shallow Profiler spares.
2.4.1.4.7.21.3	S	EQUIP - Instruments Spares 2013	This summary account captures the equipment associated with the acquisition of spare instruments.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.4.7.21.4	S	EQUP - Extension Cables - Spares 2013	This summary account captures the equipment associated with the acquisition of spare extension cables including armored seafloor cable, HP seafloor cab EO Wetmate Connectos, Cable Termination Assemblies, and ROV Wetmate Connectors.
2.4.1.4.7.22	W	Secondary Nodes Spares 2013	This work package captures the labor associated with the acquisition of RSN spare secondary infrastructure including cables, components, and sensors for Calendar Year 4 (2013).
2.4.1.4.7.22.1	S	Procure Components Secondary Nodes Spares 2013	This summary account captures the labor associated with the acquisition of spare secondary node spares including cables, components, and sensors for O Calendar Year 4 (2013).
2.4.1.4.7.22.2	S	Final Assembly and Test Secondary Nodes Spares 2013	This summary account captures the labor associated with the assembly and testing of spare secondary node spares including cables, components, and sen O&M Calendar Year 4 (2013).
2.4.1.4.7.22.2.1	S	Assembly and Test UW_APL_NODE_MP Jbox Common Spares 2013	This summary account captures the labor associated with the assembly and testing of Medium Power J-box Common Spares.
2.4.1.4.7.22.2.2	S	Assembly and Test UW_APL_NODE_MP Jbox Summit Hydrate Spares 2	This summary account captures the labor associated with the assembly and testing of spare Medium Power J-Box Summit Hydrate.
2.4.1.4.7.23	W	Vertical Mooring + Profilers Spares 2013	This work package captures the labor associated with the acquisition, assembly and testing of the spare Vertical Mooring.
2.4.1.4.7.23.1	S	Vertical Mooring + Profilers Spares 2013	This work package captures the labor associated with the acquisition of the spare Vertical Mooring.
2.4.1.4.7.23.2	S	Final Assembly and Test Vertical Mooring + Profilers Spares 2013	This work package captures the labor associated with the assembly and testing of the spare Vertical Mooring.
2.4.1.4.7.23.2.1	S	Assembly and Test Mooring Controller Spares 2013	This summary account captures the labor associated with the assembly and testing of Shallow Profiler Spare No. 1.
2.4.1.4.7.23.2.1.3	S	Assembly and Test Shallow Profiler Spare #1 2013	This summary account captures the labor associated with the assembly and testing of Shallow Profiler Spare No. 1.
2.4.1.4.7.23.2.1.4	S	Assembly and Test Shallow Profiler Spare #2 2013	This summary account captures the labor associated with the assembly and testing of Shallow Profiler Spare No. 2.
2.4.1.4.7.23.2.1.5	S	Assembly and Test Shallow Profiler Spare #3 2013	This summary account captures the labor associated with the assembly and testing of Shallow Profiler Spare No. 3.
2.4.1.4.7.24	W	Instrurments Spares 2013	This work package captures the labor associated with the acquisition, inspection and testing of RSN spare instruments for O&M Calendar Year 4 (2013).
2.4.1.4.7.24.1	S	Procure Sensors Spares 2013	This summary account captures the labor associated with the procurment of spare instruments for O&M Calendar Year 4 (2013).
2.4.1.4.7.24.2	S	Inpection and Test Sensors Bottom, Axial	This summary account captures the labor associated with the inspection and test of spare instruments for O&M Calendar Year 4 (2013).
2.4.1.4.7.25	W	Extension Cables Spares 2013	This work package captures the labor associated with the acquisition of RSN spare extension cables for O&M Calendar Year 4 (2013).
2.4.1.4.7.25.1	S	Procure Components Extension Cables -Spares 2013	This summary account captures the labor associated with the procurement of spare extension cables for O&M Calendar Year 4 (2013) including ROV Optic Connectors, ROV Electrical Connectors, Seafloor Cable, and Armored seafloor Cable.
2.4.1.5	S	OM Year 5 (2014)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 5 (2014). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.5.1	C	Operations - 2014	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, He Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 5 (2014).
2.4.1.5.1.20	W	MATL - Operations - 2014	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Cal Year 5 (2014).
2.4.1.5.1.21	W	TRVL - Operations - 2014	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2014).
2.4.1.5.1.22	W	SUBS - Operations - 2014	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 5 (2014).
2.4.1.5.1.23	W	EQUP - Operations - 2014	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M C Year 5 (2014).
2.4.1.5.1.24	W	Project Controls/Finance - 2014	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance projec O&M Calendar Year 5 (2014).. The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsib Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also c the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.5.1.25	W	Documentation 2014	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 5 (2014).
2.4.1.5.1.26	W	Environmental Health and Safety - 2014	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S for O&M Calendar Year 5 (2014). Managment of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.5.1.27	W	QA/QC Inspections - 2014	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN for Calendar Year 5 (2014). Managment of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained aspects of the program.
2.4.1.5.1.28	W	Monitoring and Surveillance - Assurance - 2014	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 5 (2014).
2.4.1.5.1.29	W	Network Planning & Maintenance - Fulfillment - 2014	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.5.1.30	W	Data Management - 2014	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 5 (2014).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.5.1.31	W	Maintenance Cruise Planning - 2014	This work package captures the level of effort for labor associated with the managmenet and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastrcuture for the RSN; and development of the Field Operation Handbooks.
2.4.1.5.2	C	Sustaining Engineering - 2014	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 5 (2014).
2.4.1.5.2.20	W	MATL - Sustaining Engineering - 2014	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 5 (2014).
2.4.1.5.2.21	W	TRVL - Sustaining Engineering - 2014	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 5 (2014).
2.4.1.5.2.22	W	SUBS - Sustaining Engineering - 2014	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 5 (2014).
2.4.1.5.2.23	W	EQUP - Sustaining Engineering - 2014	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for (Calendar Year 5 (2014).
2.4.1.5.2.24	W	Engineering Oversight / Support - 2014	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M I the project for O&M Calendar Year 5 (2014). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.
2.4.1.5.2.25	W	APL Technical Support Center - 2014	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and p support for the RSN.
2.4.1.5.3	C	Education and Public Engagement - 2014	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories a public for the RSN for O&M Calendar Year 5 (2014).
2.4.1.5.3.20	W	Community Interest and Information - 2014	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 5 (2014).
2.4.1.5.3.21	W	Other Observatories - 2014	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 5 (201
2.4.1.5.3.22	W	Communication and Outreach - 2014	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2014).
2.4.1.5.4	C	Transmission Facilities - 2014	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to supp ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 5 (2014). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.5.4.20	W	MATL - Transmission Facilities - 2014	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Mai phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.4.21	W	TRVL - Transmission Facilities - 2014	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.4.22	W	SUBS - Transmission Facilities - 2014	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 5 (2014). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Staion; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.5.4.23	W	EQUP - Transmission Facilities - 2014	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.4.24	W	Portland Oregon CyberPoP - 2014	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the leased space in the Pittock Buil Portland, OR for O&M Calendar Year 5 (2014). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.5.4.25	W	Pacific City Oregon Shore Facility - 2014	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the 4,000 sq ft of space at the Pacif OR Shore Staion; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 5 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.5.4.26	W	Logistics/Maintenance Facility, Oregon - 2014	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of a logistics and maintenance facility Oregon coast for O&M Calendar Year 5 (2014). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.5.4.27	W	Logistics/Maintenance Facility - Washington - 2014	This work package captures the level of effort for labor associated with the managment, oversight, and maintenancewith of a logistics and maintenance fa Washington for O&M Calendar Year 5 (2014). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.5.5	C	Backhaul - 2014 DEPRECATED	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.5.6	C	Primary Infrastructure - 2014	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, anc America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 5 (2014).
2.4.1.5.6.20	W	MATL - Primary Infrastructure - 2014	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.6.21	W	TRVL - Primary Infrastructure - 2014	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.6.22	W	SUBS - Primary Infrastructure - 2014	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.6.23	W	EQUP - Primary Infrastructure - 2014	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 5 (2014).
2.4.1.5.6.24	W	Regulatory Compliance - 2014 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 5 (20 large compnent of this will be support of the Oregon Fishermens Cable Committee.
2.4.1.5.6.25	W	Wet Plant Maintenance - 2014 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 5 (2014), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.5.6.26	W	Wet Plant Spares - 2014 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 5 (2014).
2.4.1.5.7	C	Secondary Infrastructure - 2014	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infras composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 5 (2014).
2.4.1.5.7.20	W	MATL - Secondary Infrastructure - 2014	This work package captures the material associated with the acquisition of RSN spare secondary infrastructure including cables, components, and sensors Calendar Year 5 (2014).
2.4.1.5.7.21	W	EQUIP - Spares 2014 Secondary Infrasture	This work package captures the equipment associated with the secondary node spares, vertical mooring and profilers, instruments and extension cables in Calenday Year 5 (2014).
2.4.1.5.7.21.2	S	EQUP - Vertical Mooring + Profilers Spares 2014	This summary account captures the equipment associated with the Vertoical Mooring and Profiler spares.
2.4.1.5.7.21.2.1	S	EQUP - Float Junction Box Spares 2014	This summary account captures the equipment associated with the spare Float Junction box including titanium housing, ROV connectors and frame.
2.4.1.5.7.21.2.2	S	EQUP - Deep Profiler Spares 2014	This summary account captures the equipment associated with the Deep Profiler spare.
2.4.1.5.7.21.2.3	S	EQUP- Vertical Mooring Structure Spares 2014	This summary account captures the equipment associated with the Vertical Mooring structure spares including EOM Cable and Seafloor Cable.
2.4.1.5.7.21.3	S	EQUIP - Instruments Spares 2014	This summary account captures the equipment associated with the acquisition of spare instruments including ADCPT, ADCPS, BOTPT, CAMHD, CAMDS, OT HYDLF, MASSP, OBSBB, OBSSP, PREST, TMPSF, and VEL3D.
2.4.1.5.7.21.4	S	EQUP - Extension Cables - Spares 2014	This summary account captures the equipment associated with the acquisition of spare extension cables including armored seafloor cable, HP seafloor cab EO Wetmate Connectos, Cable Termination Assemblies, and ROV Wetmate Connectors.
2.4.1.5.7.22	W	Secondary Nodes Spares 2014	This work package captures the labor associated with the acquisition of secondary node spares in O&M Calenday Year 5 (2014).
2.4.1.5.7.23	W	Vertical Mooring + Profilers Spares 2014	This work package captures the labor associated with the acquisition , assembly and testing of Vertical Mooring and Profiler spares including connectors ar pressure houing for O&M Calendar Year 5 (2014).
2.4.1.5.7.23.1	S	Vertical Mooring + Profilers Spares 2014	This summary account captures the labor associated with the acquisition of Vertical Mooring and Profiler spares including connectors and pressure houing Calendar Year 5 (2014).
2.4.1.5.7.23.2	S	Final Assembly and Test Vertical Mooring + Profilers Spares 2014	This summary account captures the labor associated with the assemblt and testing of spare float junction box and the deep profiler spares for Calendar Ye (2014).
2.4.1.5.7.23.2.1	S	Assembly and Test Float Junction Box Spares 2014	This summary account captures the labor associated with the assembly and testing of spare float junction box for Calendar Year 5 (2014).
2.4.1.5.7.23.2.2	S	Assembly and Test Deep Profiler Spares 2014	This summary account captures the labor associated with the assembly and testing of the deep profiler spares for Calendar Year 5 (2014).
2.4.1.5.7.24	W	Instrurments Spares 2014	This work package captures the labor associated with the acquisition, inspection and testing of RSN spare instruments for O&M Calendar Year 5 (2014).
2.4.1.5.7.24.1	S	Procure Sensors Spares 2014	This summary account captures the labor associated with the procurment of spare instruments for O&M Calendar Year 5 (2014).
2.4.1.5.7.24.2	S	Inpection and Test Sensors Bottom, Axial	This summary account captures the labor associated with the inspection and test of spare instruments for O&M Calendar Year 5 (2014).
2.4.1.5.7.25	W	Extension Cables Spares 2014	This work package captures the labor associated with the acquisition of RSN spare extension cables for O&M Calendar Year 5 (2014).
2.4.1.5.7.25.1	S	Procure Components Extension Cables -Spares 2014	This summary account captures the labor associated with the procurement of spare extension cables for O&M Calendar Year 5 (2014) including ROV Optic Connectors, ROV Electrical Connectors, Seafloor Cable, and Armored seafloor Cable.
2.4.1.5.8	C	Maintenance Cruise No. 1 - 2014	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 5
2.4.1.5.8.20	W	MATL - Maintenance Cruise No. 1 - 2014	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 5 (2014).
2.4.1.5.8.21	W	TRVL - Maintenance Cruise No. 1 - 2014	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 5 (2014).
2.4.1.5.8.22	W	SUBS - Maintenance Cruise No. 1 - 2014	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 5 (2014).
2.4.1.5.8.23	W	EQUP - Maintenance Cruise No. 1 - 2014	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 5 (2014).
2.4.1.5.8.24	W	Maintenance Cruise No. 1 - 2014	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 5 (2014).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.6	S	OM Year 6 (2015)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 6 (2015). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.6.1	C	Operations - 2015	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, Hea Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 6 (2015).
2.4.1.6.1.20	W	MATL - Operations - 2015	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Cal Year 6 (2015).
2.4.1.6.1.21	W	TRVL - Operations - 2015	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2015).
2.4.1.6.1.22	W	SUBS - Operations - 2015	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 6 (2015).
2.4.1.6.1.23	W	EQUP - Operations - 2015	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M Ca Year 6 (2015).
2.4.1.6.1.24	W	Project Controls/Finance - 2015	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance projec O&M Calendar Year 6 (2015).. The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsib Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also c the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.6.1.25	W	Documentation 2015	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 6 (2015).
2.4.1.6.1.26	W	Environmental Health and Safety - 2015	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S for O&M Calendar Year 6 (2015). Managment of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.6.1.27	W	QA/QC Inspections - 2015	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN for Calendar Year 6 (2015). Managment of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained aspects of the program.
2.4.1.6.1.28	W	Monitoring and Surveillance - Assurance - 2015	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 6 (2015).
2.4.1.6.1.29	W	Network Planning & Maintenance - Fulfillment - 2015	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.6.1.30	W	Data Management - 2015	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 6 (2015).
2.4.1.6.1.31	W	Maintenance Cruise Planning - 2015	This work package captures the level of effort for labor associated with the managmenet and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastrcuture for the RSN; and development of the Field Operation Handbooks.
2.4.1.6.2	C	Sustaining Engineering - 2015	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 6 (2015).
2.4.1.6.2.20	W	MATL - Sustaining Engineering - 2015	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 6 (2015).
2.4.1.6.2.21	W	TRVL - Sustaining Engineering - 2015	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 6 (2015).
2.4.1.6.2.22	W	SUBS - Sustaining Engineering - 2015	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 6 (2015).
2.4.1.6.2.23	W	EQUP - Sustaining Engineering - 2015	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for (Calendar Year 6 (2015).
2.4.1.6.2.24	W	Engineering Oversight / Support - 2015	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M I the project for O&M Calendar Year 6 (2015). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.
2.4.1.6.2.25	W	APL Technical Support Center - 2015	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and p support for the RSN.
2.4.1.6.3	C	Education and Public Engagement - 2015	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories a public for the RSN for O&M Calendar Year 6 (2015).
2.4.1.6.3.20	W	Community Interest and Information - 2015	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 6 (2015).
2.4.1.6.3.21	W	Other Observatories - 2015	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 6 (201

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.6.3.22	W	Communication and Outreach - 2015	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2015).
2.4.1.6.4	C	Transmission Facilities - 2015	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to sup ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 6 (2015). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.6.4.20	W	MATL - Transmission Facilities - 2015	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Mai phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.4.21	W	TRVL - Transmission Facilities - 2015	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.4.22	W	SUBS - Transmission Facilities - 2015	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 6 (2015). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Staion; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.6.4.23	W	EQUP - Transmission Facilities - 2015	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.4.24	W	Portland Oregon PoP - 2015	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the leased space in the Pittock Buil Portland, OR for O&M Calendar Year 6 (2015). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.6.4.25	W	Pacific City Oregon Shore Facility - 2015	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the 4,000 sq ft of space at the Pacif OR Shore Staion; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 6 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.6.4.26	W	Logistics/Maintenance Facility, Oregon - 2015	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of a logistics and maintenance facility Oregon coast for O&M Calendar Year 6 (2015). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.6.4.27	W	Logistics/Maintenance Facility - Washington - 2015	This work package captures the level of effort for labor associated with the managment, oversight, and maintenancewith of a logistics and maintenance fa Washington for O&M Calendar Year 6 (2015). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.6.5	C	Backhaul - 2015 DEPRECATED	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.
2.4.1.6.6	C	Primary Infrastructure - 2015	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, and America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 6 (2015).
2.4.1.6.6.20	W	MATL - Primary Infrastructure - 2015	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.6.21	W	TRVL - Primary Infrastructure - 2015	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.6.22	W	SUBS - Primary Infrastructure - 2015	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.6.23	W	EQUP - Primary Infrastructure - 2015	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 6 (2015).
2.4.1.6.6.24	W	Regulatory Compliance - 2015 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 6 (20 large compnent of this will be support of the Oregon Fishermens Cable Committee.
2.4.1.6.6.25	W	Wet Plant Maintenance - 2015 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 6 (2015), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.6.6.26	W	Wet Plant Spares - 2015 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 6 (2015).
2.4.1.6.7	C	Secondary Infrastructure - 2015	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infra composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 6 (2015).
2.4.1.6.7.20	W	MATL - Secondary Infrastructure Spares - 2015	This work package captures the material associated with the acquisition of RSN spare secondary infrastructure.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.6.7.21	W	TRVL - Secondary Infrastructure Spares - 2015	This work package captures the travel associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.6.7.22	W	SUBS - Secondary Infrastructure Spares - 2015	This work package captures the subcontracts associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.6.7.23	W	EQUP - Secondary Infrastructure Spares - 2015	This work package captures the equipment associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.6.8	C	Maintenance Cruise No. 1 - 2015	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 6
2.4.1.6.8.20	W	MATL - Maintenance Cruise No. 1 - 2015	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.8.21	W	TRVL - Maintenance Cruise No. 1 - 2015	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.8.22	W	SUBS - Maintenance Cruise No. 1 - 2015	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.8.23	W	EQUP - Maintenance Cruise No. 1 - 2015	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.8.24	W	Maintenance Cruise No. 1 - 2015	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.9	C	Maintenance Cruise No. 2 - 2015	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 6
2.4.1.6.9.20	W	MATL - Maintenance Cruise No. 2 - 2015	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.9.21	W	TRVL - Maintenance Cruise No. 2 - 2015	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.9.22	W	SUBS - Maintenance Cruise No. 2 - 2015	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.9.23	W	EQUP - Maintenance Cruise No. 2 - 2015	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.6.9.24	W	Maintenance Cruise No. 2 - 2015	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 6 (2015).
2.4.1.7	S	OM Year 7 (2016)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 7 (2016). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.7.1	C	Operations - 2016	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, Hea Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 7 (2016).
2.4.1.7.1.20	W	MATL - Operations - 2016	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Cal Year 7 (2016).
2.4.1.7.1.21	W	TRVL - Operations - 2016	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2016).
2.4.1.7.1.22	W	SUBS - Operations - 2016	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 7 (2016).
2.4.1.7.1.23	W	EQUP - Operations - 2016	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M C Year 7 (2016).
2.4.1.7.1.24	W	Project Controls/Finance - 2016	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance projec O&M Calendar Year 7 (2016).. The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsib Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also c the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.7.1.25	W	Documentation 2016	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 7 (2016).
2.4.1.7.1.26	W	Environmental Health and Safety - 2016	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S for O&M Calendar Year 7 (2016). Managment of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.7.1.27	W	QA/QC Inspections - 2016	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN for Calendar Year 7 (2016). Managment of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained aspects of the program.
2.4.1.7.1.28	W	Monitoring and Surveillance - Assurance - 2016	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 7 (2016).
2.4.1.7.1.29	W	Network Planning & Maintenance - Fulfillment - 2016	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.7.1.30	W	Data Management - 2016	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 7 (2016).
2.4.1.7.1.31	W	Maintenance Cruise Planning - 2016	This work package captures the level of effort for labor associated with the managmenet and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastrcuture for the RSN; and development of the Field Operation Handbooks.
2.4.1.7.2	C	Sustaining Engineering - 2016	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 7 (2016).
2.4.1.7.2.20	W	MATL - Sustaining Engineering - 2016	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 7 (2016).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.7.2.21	W	TRVL - Sustaining Engineering - 2016	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 7 (2016).
2.4.1.7.2.22	W	SUBS - Sustaining Engineering - 2016	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 7 (2016).
2.4.1.7.2.23	W	EQUP - Sustaining Engineering - 2016	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for (Calendar Year 7 (2016).
2.4.1.7.2.24	W	Engineering Oversight / Support - 2016	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M I the project for O&M Calendar Year 7 (2016). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.
2.4.1.7.2.25	W	APL Technical Support Center - 2016	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and p support for the RSN.
2.4.1.7.3	C	Education and Public Engagement - 2016	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories a public for the RSN for O&M Calendar Year 7 (2016).
2.4.1.7.3.20	W	Community Interest and Information - 2016	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 7 (2016).
2.4.1.7.3.21	W	Other Observatories - 2016	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 7 (201
2.4.1.7.3.22	W	Communication and Outreach - 2016	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2016).
2.4.1.7.4	C	Transmission Facilities - 2016	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to supp ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 7 (2016). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.7.4.20	W	MATL - Transmission Facilities - 2016	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Mai phase of the project for O&M Calendar Year 7 (2016).
2.4.1.7.4.21	W	TRVL - Transmission Facilities - 2016	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 7 (2016).
2.4.1.7.4.22	W	SUBS - Transmission Facilities - 2016	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 7 (2016). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Staion; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.7.4.23	W	EQUP - Transmission Facilities - 2016	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 7 (2016).
2.4.1.7.4.24	W	Portland Oregon PoP - 2016	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the leased space in the Pittock Buil Portland, OR for O&M Calendar Year 7 (2016). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.
2.4.1.7.4.25	W	Pacific City Oregon Shore Facility - 2016	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the 4,000 sq ft of space at the Pacif OR Shore Staion; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 7 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.7.4.26	W	Logistics/Maintenance Facility, Oregon - 2016	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of a logistics and maintenance facility Oregon coast for O&M Calendar Year 7 (2016). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.7.4.27	W	Logistics/Maintenance Facility - Washington - 2016	This work package captures the level of effort for labor associated with the managment, oversight, and maintenancewith of a logistics and maintenance fa Washington for O&M Calendar Year 7 (2016). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.7.5	C	Backhaul - 2016 DEPRECATED	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.
2.4.1.7.6	C	Primary Infrastructure - 2016	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, anc America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 7 (2016).
2.4.1.7.6.20	W	MATL - Primary Infrastructure - 2016	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 7 (2016).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.7.6.21	W	TRVL - Primary Infrastructure - 2016	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 7 (2016).
2.4.1.7.6.22	W	SUBS - Primary Infrastructure - 2016	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 7 (2016).
2.4.1.7.6.23	W	EQUP - Primary Infrastructure - 2016	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 7 (2016).
2.4.1.7.6.24	W	Regulatory Compliance - 2016 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 7 (20 large compnent of this will be support of the Oregon Fishermens Cable Committee.
2.4.1.7.6.25	W	Wet Plant Maintenance - 2016 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 7 (2016), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.7.6.26	W	Wet Plant Spares - 2016 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 7 (2016).
2.4.1.7.7	C	Secondary Infrastructure - 2016	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infra composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 7 (2016).
2.4.1.7.7.20	W	MATL - Secondary Infrastructure Spares - 2016	This work package captures the material associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.7.7.21	W	TRVL - Secondary Infrastructure Spares - 2016	This work package captures the travel associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.7.7.22	W	SUBS - Secondary Infrastructure Spares - 2016	This work package captures the subcontracts associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.7.7.23	W	EQUP - Secondary Infrastructure Spares - 2016	This work package captures the equipment associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.7.8	C	Maintenance Cruise No. 1 - 2016	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 7
2.4.1.7.8.20	W	MATL - Maintenance Cruise No. 1 - 2016	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.8.21	W	TRVL - Maintenance Cruise No. 1 - 2016	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.8.22	W	SUBS - Maintenance Cruise No. 1 - 2016	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.8.23	W	EQUP - Maintenance Cruise No. 1 - 2016	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.8.24	W	Maintenance Cruise No. 1 - 2016	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.9	C	Maintenance Cruise No. 2 - 2016	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 7
2.4.1.7.9.20	W	MATL - Maintenance Cruise No. 2 - 2016	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.9.21	W	TRVL - Maintenance Cruise No. 2 - 2016	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.9.22	W	SUBS - Maintenance Cruise No. 2 - 2016	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.9.23	W	EQUP - Maintenance Cruise No. 2 - 2016	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.7.9.24	W	Maintenance Cruise No. 2 - 2016	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 7 (2016).
2.4.1.8	S	OM Year 8 (2017)	This summary account includes all resources, including labor, equipment, subcontracts, travel and material, to prepare for and fulfill RSN Operations and Maintenance (O&M) activities for O&M Calendar Year 8 (2017). This summary account captures all of the O&M work assigned to the RSN Implementing Organization for Operations, Sustaining Engineering, Education and Public Engagement, Transmission Facilities, and Primary and Secondary Infrastructure.
2.4.1.8.1	C	Operations - 2017	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Project Management/Controls, Environmental, He Safety, Network Planning and Maintenance, and preparation for transition of documentation from the construction environment to the maintenance life c O&M Calendar Year 8 (2017).
2.4.1.8.1.20	W	MATL - Operations - 2017	This work package captures the material associated with the project management and controls of the RSN Operations & Maintenance project for O&M Ca Year 8 (2017).
2.4.1.8.1.21	W	TRVL - Operations - 2017	This work package captures the travel associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calen (2017).
2.4.1.8.1.22	W	SUBS - Operations - 2017	This work package captures the subcontracts associated with the project management and controls of the RSN Operations & Maintenance project for O&M Calendar Year 8 (2017).
2.4.1.8.1.23	W	EQUP - Operations - 2017	This work package captures the equipment associated with the project management and control of the RSN Operations & Maintenance project for O&M C Year 8 (2017).
2.4.1.8.1.24	W	Project Controls/Finance - 2017	This work package captures the level of effort for labor associated with the project management and controls of the RSN Operations & Maintenance proje O&M Calendar Year 8 (2017).. The RSN IO will be staffed by a team of administrators, scientists, engineers, educators, and their staffs. The main responsib Team will be to provide operational oversight to ensure that all essential RSN mission requirements are met. The Team will also provide the external communications link to the National Science Foundation (NSF) and Ocean Leadership (OL), the various OOI users, and the public in general. They will also the daily operation of the RSN, as well as prepare and present to the sponsoring agency monthly and annual budgetary information and reports.
2.4.1.8.1.25	W	Documentation 2017	This work package captures the labor for configuring, data entry and start-up of an RSN network system integrated to the RSN framework to manage and v as-built network documentation in the Operations & Maintenance environment for O&M Calendar Year 8 (2017).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.8.1.26	W	Environmental Health and Safety - 2017	This work package captures the level of effort for labor associated with the management and oversight of the RSN Environmental Health and Safety (EH&S) for O&M Calendar Year 8 (2017). Managment of the EH&S program will be in accordance with the RSN EH&S Program Plan.
2.4.1.8.1.27	W	QA/QC Inspections - 2017	This work package captures the level of effort for the labor associated with the Quality Assurance and Quality Control (QA/QC) of materials for the RSN for Calendar Year 8 (2017). Managment of the QA/QC program will be in accordance with the RSN Quality Assurance Plan to ensure that quality is maintained aspects of the program.
2.4.1.8.1.28	W	Monitoring and Surveillance - Assurance - 2017	This work package captures the level of effort for labor associated with the Assurance component of Network Operations highlighted by problem handling resolution for O&M Calendar Year 8 (2017).
2.4.1.8.1.29	W	Network Planning & Maintenance - Fulfillment - 2017	This work package captures the level of effort for labor associated with planning and maintenance fulfillment. Essential success of the RSN O&M will be tie developing and implementing strong processes and procedures for operating the network and the supporting maintenance plan.
2.4.1.8.1.30	W	Data Management - 2017	This work package captures the level of effort for labor associated with the Data Management including the data QA/QC and calibration/verification; meta management; and data product management for O&M Calendar Year 8 (2017).
2.4.1.8.1.31	W	Maintenance Cruise Planning - 2017	This work package captures the level of effort for labor associated with the managmenet and support of Network Operations for wet maintenance and rep Primary and Secondary Infrastrcuture for the RSN; and development of the Field Operation Handbooks.
2.4.1.8.2	C	Sustaining Engineering - 2017	This control account captures the labor, equipment, subcontracts, travel, and materials associated with engineering management and oversight of RSN Op & Maintenance for O&M Calendar Year 8 (2017).
2.4.1.8.2.20	W	MATL - Sustaining Engineering - 2017	This work package captures the material associated with the engineering management and oversight of the RSN Operations & Maintenance project for O& Calendar Year 8 (2017).
2.4.1.8.2.21	W	TRVL - Sustaining Engineering - 2017	This work package captures the travel associated with the engineering management and oversight of the RSN Operations & Maintenance project for O&M Year 8 (2017).
2.4.1.8.2.22	W	SUBS - Sustaining Engineering - 2017	This work package captures the subcontracts associated with the engineering management and oversight of the RSN Operations & Maintenance project fo Calendar Year 8 (2017).
2.4.1.8.2.23	W	EQUP - Sustaining Engineering - 2017	This work package captures the equipment associated with the engineering management and oversight of the RSN Operations & Maintenance project for Calendar Year 8 (2017).
2.4.1.8.2.24	W	Engineering Oversight / Support - 2017	This work package captures the level of effort for labor associated with the engineering oversight and support at the UW APL for the RSN during the O&M the project for O&M Calendar Year 8 (2017). Responsibilities of the engineering effort will include configuration management, risk management, O&M process/procedures, interface management, equipment technical support, implementation of appropriate quality assurance processes and measurements support and participation in team meetings and system-level reviews.
2.4.1.8.2.25	W	APL Technical Support Center - 2017	This work package captures the level of effort for labor associated with engineering support of network operations for maintenance, fault resolution, and support for the RSN.
2.4.1.8.3	C	Education and Public Engagement - 2017	This control account captures the level of effort for labor associated with coordination and engagement with the science community, other observatories public for the RSN for O&M Calendar Year 8 (2017).
2.4.1.8.3.20	W	Community Interest and Information - 2017	This work package captures the level of effort for labor associated with engaging the science community at both the national and international level for the O&M Calendar Year 8 (2017).
2.4.1.8.3.21	W	Other Observatories - 2017	This work package captures the level of effort for labor associated with exchange and coordination with other observatories for O&M Calendar Year 8 (201
2.4.1.8.3.22	W	Communication and Outreach - 2017	This work package captures the level of effort for labor associated with supporting the efforts of the EPE IO in public outreach for the RSN for O&M Calend (2017).
2.4.1.8.4	C	Transmission Facilities - 2017	The Transmission Facilities control account captures the lease costs associated with space in various facilities within Oregon and Washington states to supp ongoing operation and maintenance of the RSN and Cyberinfrastructure for O&M Calendar Year 8 (2017). The leased space comprises facilities for the Paci Shore Station, Point-of-Presence (POP) in Portland, OR, and logistics/maintenance facilities in Oregon and Washington state.
2.4.1.8.4.20	W	MATL - Transmission Facilities - 2017	This work package captures the material associated with the management and maintenance of the transmission facilities during the RSN Operations & Ma phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.4.21	W	TRVL - Transmission Facilities - 2017	This work package captures the travel associated with the management and maintenance of the transmission facilities during the RSN Operations & Maint phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.4.22	W	SUBS - Transmission Facilities - 2017	This work package captures the subcontracts associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 8 (2017). This work package captures the lease costs associated with up to six rack spaces in the Building at Portland, OR; the monthly lease and utility costs associated with 4,000 sq ft of space at the Pacific City, OR Shore Staion; lease costs associated maintaining logistic and maintenance facilities in Oregon and Washington.
2.4.1.8.4.23	W	EQUP - Transmission Facilities - 2017	This work package captures the equipment associated with the management and maintenance of the transmission facilities during the RSN Operations & Maintenance phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.4.24	W	Portland Oregon PoP - 2017	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the leased space in the Pittock Buil Portland, OR for O&M Calendar Year 8 (2017). The Pittock Building is a commercial datacenter type co-location facility, acting as a key internet data hub fo metro Portland area. In a co-location facility the landlord provides high availability electrical power, infrastructure to connect to various telecommunicatio providers, fire detection/suppression, environmental controls (HVAC), security and onsite 24/7 technical support.

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.1.8.4.25	W	Pacific City Oregon Shore Facility - 2017	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of the 4,000 sq ft of space at the Pacif OR Shore Staion; including day-to-day operations and management of subcontractor maintenance, security and station access for O&M Calendar Year 8 (2 facility landlord will provide high availability electrical power, infrastructure to connect to a terrestrial telecommunications provider, fire detection/suppre environmental controls (HVAC), security, temporary storage, and land for the ground anode.
2.4.1.8.4.26	W	Logistics/Maintenance Facility, Oregon - 2017	This work package captures the level of effort for labor associated with the managment, oversight, and maintenance of a logistics and maintenance facility Oregon coast for O&M Calendar Year 8 (2017). The facilities will be established to support the storage and maintenance of secondary infrastructure includ instruments and cables. RSN Field Engineers will support maintenance, calibration, and vendor suggested technical refresh: as well as the ability to respon issues at either the cable station or CyberPOP.
2.4.1.8.4.27	W	Logistics/Maintenance Facility - Washington - 2017	This work package captures the level of effort for labor associated with the managment, oversight, and maintenancewith of a logistics and maintenance fa Washington for O&M Calendar Year 8 (2017). This facility will be established to support the storage and maintenance of secondary infrastructure including extension cables and instruments.
2.4.1.8.5	C	Backhaul - 2017 DEPRECATED	Deprecated - Backhaul lease payments transferred to Ocean Leadership. Management and oversight of the backhaul lease agreement will be conducted by through the Operations Control Account.
2.4.1.8.6	C	Primary Infrastructure - 2017	This control account captures the costs associated with wet plant maintenance costs, long-term storage of the primary infrastructure wet plant spares, and America Zone Cable Maintenance Agreement and Oregon Fisherman's Cable Committee support; regulatory permit compliance requirement support, wet maintenance, and the acquisition and long-term storage of the primary infrastructure wet plant spares for O&M Calendar Year 8 (2017).
2.4.1.8.6.20	W	MATL - Primary Infrastructure - 2017	This work package captures the material associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.6.21	W	TRVL - Primary Infrastructure - 2017	This work package captures the travel associated with the management of the Primary Infrastructure; including support of regulatory permit compliance requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.6.22	W	SUBS - Primary Infrastructure - 2017	This work package captures the subcontracts associated with the management of the Primary Infrastructure; including support of regulatory permit compl requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.6.23	W	EQUP - Primary Infrastructure - 2017	This work package captures the equipment associated with the management of the Primary Infrastructure; including support of regulatory permit complia requirements, Oregon Fisherman's Cable Committee and North America Cable Zone Maintenance Agreement meetings; and oversight of wet plant spares the RSN Operations & Maintenance phase of the project for O&M Calendar Year 8 (2017).
2.4.1.8.6.24	W	Regulatory Compliance - 2017 Primary	This work package captures the level of effort labor associated with maintaining compliance with RSN permits and approvals for O&M Calendar Year 8 (20 large compnent of this will be support of the Oregon Fishermens Cable Committee.
2.4.1.8.6.25	W	Wet Plant Maintenance - 2017 Primary	This work package captures the level of effort for labor associated with wet maintenance of the Primary Infrastructure or O&M Calendar Year 8 (2017), hig by support of the North America Cable Zone Maintenance Agreement.
2.4.1.8.6.26	W	Wet Plant Spares - 2017 Primary	This work package captures the labor associated with the acquisition of wet plant and cable station spares, and the storage of the primary infrastructure sp O&M Calendar Year 8 (2017).
2.4.1.8.7	C	Secondary Infrastructure - 2017	This control account captures the labor, equipment, subcontracts, travel, and materials associated with the maintenance and repair of the secondary infra composed primarily of spare cables, components, and instruments for the RSN for O&M Calendar Year 8 (2017).
2.4.1.8.7.20	W	MATL - Secondary Infrastructure Spares - 2017	This work package captures the material associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.8.7.21	W	TRVL - Secondary Infrastructure Spares - 2017	This work package captures the travel associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.8.7.22	W	SUBS - Secondary Infrastructure Spares - 2017	This work package captures the subcontracts associated with the acquisition of RSN spare secondary infrastructure.
2.4.1.8.8	C	Maintenance Cruise No. 1 - 2017	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 8
2.4.1.8.8.20	W	MATL - Maintenance Cruise No. 1 - 2017	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.8.21	W	TRVL - Maintenance Cruise No. 1 - 2017	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.8.22	W	SUBS - Maintenance Cruise No. 1 - 2017	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.8.23	W	EQUP - Maintenance Cruise No. 1 - 2017	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.8.24	W	Maintenance Cruise No. 1 - 2017	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.9	C	Maintenance Cruise No. 2 - 2017	This control account captures the labor, equipment, subcontracts, travel, and materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 8
2.4.1.8.9.20	W	MATL - Maintenance Cruise No. 2 - 2017	This work package captures the materials associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.9.21	W	TRVL - Maintenance Cruise No. 2 - 2017	This work package captures the travel associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.9.22	W	SUBS - Maintenance Cruise No. 2 - 2017	This work package captures the subcontracts associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.9.23	W	EQUP - Maintenance Cruise No. 2 - 2017	This work package captures the equipment associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.1.8.9.24	W	Maintenance Cruise No. 2 - 2017	This work package captures the labor (seapay) associated with Maintenance Cruise No. 1 in O&M Calendar Year 8 (2017).
2.4.3	S	O&M Spares	This summary account captures the Primary Infrastructure Spares Operations & Maintenance portion of the contract signed November 2009 with L-3 Communications MariPro. The spares will include various lengths of cable, repeaters, primary nodes, splicing kits, test equipment and cable station equipn components. The Billing Schedule defines the schedule and milestones.
2.4.3.2	C	Primary Infrastructure Spares (2011)	This control account captures the Primary Infrastructure Spares Operations & Maintenance Billing Milestones for for O&M Calendar Year 2 (2011).

WBS Item	WBS Type	WBS Title	WBS Definition
2.4.3.2.0	W	SPA - Primary Infrastructure Spares (2011)	This work package captures the Single Point Adjustment (SPA) for O&M Calendar Year 2 (2011) Primary Infrastructure Spares (2011) through 4/30/2011.
2.4.3.2.20	W	O&M Submarine Cable Procurement Complete	This work package captures one of the subcontract Billing Milestones associated with the order of the spare submarine cable for Axial and Hydrate Ridge c Spare submarine cable would be utilized to repair a cable fault.
2.4.3.2.21	W	O&M Land Cable and Spare SLTE Installed	This work package captures one of the subcontract Billing Milestones associated with the installation of the land cable between the beach manhole and th station and the spare Submarine Line Terminating Equipment.
2.4.3.2.22	W	O&M Submarine Cable Delivered	This work package captures one of the subcontract Billing Milestones associated with the delivery of the spare Submarine Cable.
2.4.3.3	C	Primary Infrastructure Spares (2012)	This control account captures the Primary Infrastructure Spares Operations & Maintenance Billing Milestones for for O&M Calendar Year 3 (2012).
2.4.3.3.20	W	Spare Terminal Test Equipment (TTE) Delivered	This work package captures one of the subcontract Billing Milestones associated with the delivery of the spare Terminal Test Equipment (TTE).
2.4.3.3.21	W	Spare Manufacturing Primary Nodes Complete	This work package captures one of the subcontract Billing Milestones associated with the completion of the Primary Node manufacturing.
2.4.3.3.22	W	Delivery of Simulators	This work package captures one of the subcontract Billing Milestones associated with the delivery of the Simulators.
2.4.3.3.23	W	System Acceptance	This work package captures one of the subcontract Billing Milestones associated with System Acceptance.
2.4.3.4	C	Primary Infrastructure Spares (2013)	This control account captures the Primary Infrastructure Spares Operations & Maintenance Billing Milestones for for O&M Calendar Year 4 (2013).
2.4.3.4.20	W	Provisional Acceptance Test Documents Complete	This work package captures one of the subcontract Billing Milestones associated with Provisional Acceptance Test Documents Complete.

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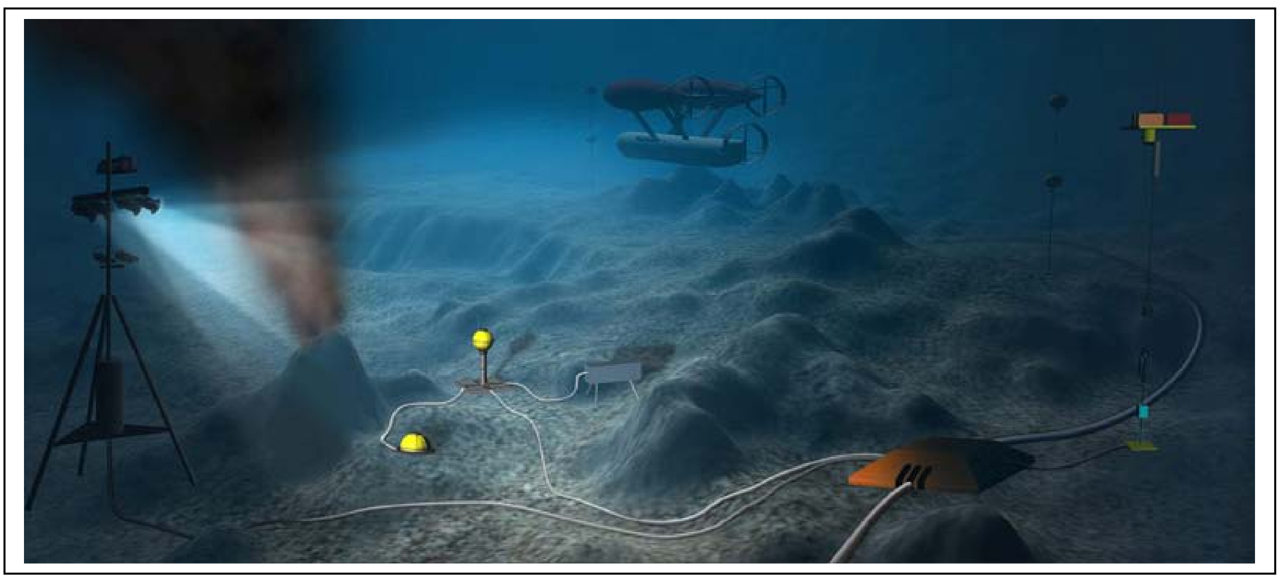

Prepared by
University of Washington for the
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May 4, 2011

Document Control Sheet

Version	Release Date	Description	By
1-00		Initial Version	M. Harrington
1-01	10/1/08	Updated Formatting	M Harrington
2-02	3/03/09	Updated for Variant	M Harrington
2-03	5/04/11	Updated for 2011 OM Review	M Harrington

Table of Contents

1. Introduction

This document presents the plans for acquisition of redundant and spare Secondary Infrastructure on the RSN. This plan is utilized to identify resources needed, acquisition of spare equipment and as a Basis of Estimate for the cost book and integrated master schedule. Justification for equipment is based on expected lifetime of equipment, maintenance intervals, system configuration and the frequency that attached sensors must be replaced. While Instruments fall into the Secondary Infrastructure category they have their own replacement strategy document and will not be covered here.

2. System Wide Assumptions/Terms

- **Primary Infrastructure**
- **Secondary Infrastructure**
- **ROV**
- **LVNode**
- **Low Power Junction Box**
- **Medium Power Junction Box**
- **Vertical Mooring**
- **Deep Profiler**
- **Shallow Profiler**
- **Replacement Equipment**
- **Spare Equipment**

3. Replacement/Maintenance Strategies

The Secondary Infrastructure is made up of LVNodes, Junction Boxes, Cable Assemblies and Vertical Moorings. Each will have their own strategy for replacement and maintenance.

3.1. LVNodes

There are five LVNodes installed in the Baseline Configuration. All are of the identical configuration. They are not connected with dry mate connectors to any equipment that needs to be serviced on an annual basis. They have a 5 year maintenance schedule. The replacement strategy is to have two LVNodes at the start of MREFC that will function as both Spares and Replacements and build one new one every 5 years. After 5 years of service the LVNodes will be replaced 1 a year for refurbish/maintenance, this will always leave one available for Spare.

3.2. Junction Boxes

3.2.1. Medium Power Junction Boxes

There are eight Medium Power Junction Boxes installed in the Baseline Configuration. Two Sites have an identical MP-JBox with two sensors hard wired that must be recovered every 3 to 5 years and two ROV wet mate connectors. Two more have a mix of Dry and Wet Mate Connectors and the rest have only ROV Wet mate connectors. They have a 5 year maintenance schedule.

The replacement strategy is to have two MP-JBoxes at the start of MREFC that will function as replacements for the three MP-JBoxes that must be swapped out every 3-5 years. Two more MP-JBox will be for the rest with all ROV Wet mate connectors that must be swapped one by one at year 5. One more spare MP-JBox will allocated for failure.

3.2.2. Low Power Junction Boxes

There are five Low Power Junction Boxes installed in the Baseline Configuration. All have a mix of Dry and Wet Mate Connectors and sensors that need to be replaced on an annual basis.

The strategy will be to have five Low Power Junction Boxes at the start of MREFC for replacement and build one new one every 5 years.

3.2.3. Interface Boxes

There are 29 Interface Boxes in the Baseline Configuration. These have no active electronics, but they must be recovered with the sensors that they are attached to. In some cases they are integrated into the same platform as the instrument electronics. The replacement strategy is to have an Interface Box for each Spare Instrument that needs one so they can be tested and installed as a single unit.

3.3. Cable Assemblies

There are over 172 cable assemblies in the RSN, 60 of which have at least one ROV Wet Mate connector and 18 of which are at least 1000m or longer. The strategy will be to stock a number of the shorter common cable assemblies and have spare parts available to make the longer cable assemblies when a failure happens.

Cables with ROV Wet Mate connectors have a design life of 25 years and are not expected to fail unless there is an external aggression.

Cable with DRY Mate connectors are shorter cables that will be replaced during routine sensor maintenance every 10 years. These can be made up each year as needed.

3.4. Vertical Mooring

There are three Vertical Moorings in the RSN part of the OOI. They have a fixed two point cable system with a 200 meter platform. This part of the Vertical mooring does not have scheduled maintenance. There will be one spare set of components for this system for repair of failed components..

All of the rest of the vertical mooring system components are designed to be maintained with an ROV.

3.4.1. Deep Profiler

The deep profiler is a buoyancy driven platform with sensors that need to be recovered once a year. Each Mooring will have a redundant Deep Profiler vehicle. There will be one set of mooring components to handle failure replacements.

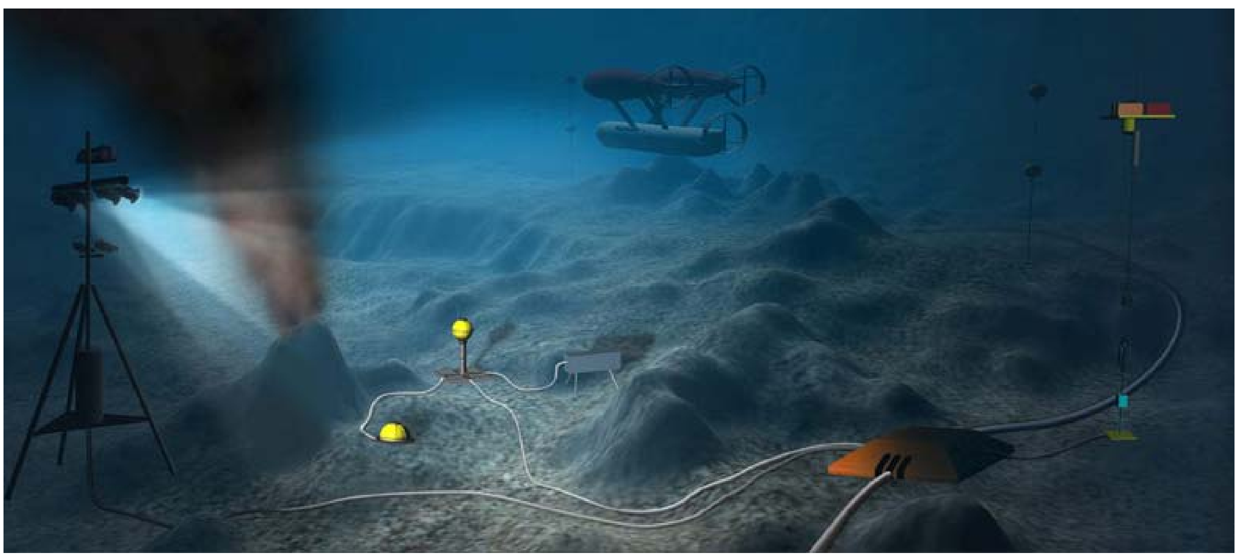
3.4.2. Shallow Profiler

The shallow profiler is a winch drive profiler that needs to be recovered once a year. Each Mooring will have a redundant Shallow Profiler

3.4.3. 200m Platform JBox

Each 200m Platform has a JBox and Mooring Controller for instruments that must be replaced every year. Each Mooring will have a redundant 200m Jbox and Mooring Controller.

OOI-Regional Scale Nodes Sensor Maintenance, Risk, and Replacement Version 2-01



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Document Control Sheet

Version	Release Date	Description	By
1.0		Initial Version	D. Kelley, S. Denny
1-01	10/1/08	Formatting/Name Update	Harrington
2-00	03/09/09	Variant Updates	Harrington
2-01	5/5/11	Inclusion of Sparing strategies, updates	Denny

Table of Contents

Table of Tables

1. Introduction

This document presents the plans for acquisition of redundant and spare sensors on the RSN and associated FTE's for maintenance and QA of the sensors. This plan can be utilized to identify resources needed acquisition of sensors and as a Basis of Estimate for the cost book and integrated master schedule. Justification for sensors is provided in the Science User Requirements, and detailed information on sensor specifications, deployment requirements, and example sensors are provided in the RSN Core Sensor Book.

2. System Wide Assumptions/Terms

Core Commercial Sensor – (CC) a sensor that is "off the shelf" and acquired from a commercial facility that will be purchased as part of the MREFC acquisition.

Core Non-Commercial – (CN-C) a sensor that is designed and fabricated by an investigator that will be purchased or leased as part of the MREFC acquisition. [Note: previously call PI Sensors, however the nomenclature was confusing when discussing future potential instruments developed by other PI's, non-core instruments.]

Class 1 Sensor – A sensor that is robust/durable in the environment of deployment and will likely only need replaced every 3-5 years.

Class 2 Sensor – A sensor that is durable, but because of environmental conditions will require replacement annually for cleaning and/or recalibration.

Class 3 Sensor – A sensor, typically deployed in extreme environments (e.g. high temperature vents), which will require annual replacement due to wear on parts.

Class 4 Sensor – A sensor that requires annual replacement as required by the need to recover samples obtained by that sensor. Typically these sensors will require replacement of expendables, and some sensor components (e.g. pumps).

Developmental Sensor – A sensor that has been used in the field with a history of operating under the required conditions, but which may not have history of long-term deployments. This sensor may be a one-off modification of an established sensor.

Gas-tight Sample – A titanium sample bottle under vacuum that takes samples of hydrothermal vent fluids without release of volatiles during decompression as the samples are brought up through the water column. They are routinely used in hydrothermal work.

Major Sampler – A titanium, syringe-like bottle that is used to take samples of vent and seep fluids: it does not keep the samples under sampling pressure so the fluids degas during recovery.

Proven Sensor – A sensor that has a history of sustained use/functionality in the environment in

which it is going to be deployed on the OOI and which returns high quality data throughout the deployment cycle.
Risk Low: A sensor that is Low Risk is a proven sensor with a strong history of operating under the required environmental conditions and returning reliable data over the operational cycle.

Risk Medium: A sensor that is Medium Risk is a sensor that has a proven history of operating under the required environmental conditions and returning reliable data for some period of time. This sensor may be susceptible to biofouling, drift, etc such that it may not function properly for an entire deployment cycle. A Medium Risk sensor may also include a sensor that has only relatively recently been developed and has a limited history of data collection.

Risk High: A High Risk Sensor is a sensor that may or may/not be proven, and that typically has a short operational life-time in the environment of deployment. These sensors may be particularly susceptible to biofouling and drift over short time scales (< 6 months), and may still be, in part, in a developmental stage.

ROV – Remotely Operated Vehicle that is tethered to the ship by an optical cable.

Seismonument – A cement housing with a hole drilled in it for insertion of short-period seismometers. This provides strong coupling to the seafloor in areas where instrument holes have not been drilled in the bedrock. The ~ rectangular-shaped blocks can be deployed and recovered by ROV or submersible.

Turn – replacement instrument for one that is already deployed. Many instruments require annual calibration and refurbishment, thus utilizing a turn will result more system up-time and less ship time.

3. Core Seafloor Sensors

This section describes seafloor sensors on the RSN, the anticipated maintenance needs that drive redundancy requirements, and the number of redundant sensors anticipated to be required, as well as spares. The total number of different kinds of seafloor sensors on the RSN totals 17 of which 8 are Class 1 sensors. Table 1 includes a summary of these sensors, their cost and location on the RSN, and the justification for their class. Based on field experience and knowledge of these sensors, each sensor is also evaluated in terms of risk, with a follow-on discussion of mitigation strategy. Figure 1 provides a summary of the RISK versus Maintenance (class) considerations for each seafloor sensor. There are 68 total seafloor sensors, of which 92% are Low Risk, 6% are Medium Risk, and 2% are Medium/High Risk.

Assumptions:
The entire suite of RSN sensors have been deployed and are operational.
This covers only sensors on the RSN.

3.1. Digital Still Camera, Pan and Tilt, Strobe – Risk Medium, Class 2-3 (CC-CN-C).

This camera will be an Ethernet camera with pan and tilt capabilities that will take at least 4MB resolution images every 15/sec. There will be two of these sensors on the RSN, one each at

Hydrate Ridge and at Axial Seamount. This sensor meets the science requirements to image the dynamic changes in at least one methane seep associated with gas hydrate deposits, an active hydrothermal site, and associated micro- and macrofauna (A4 and A6). The components are commercial, but will require placement into titanium pressure housings, integration of the pan and tilt system, and fabrication of frames. The camera is deployed and optimally placed with a

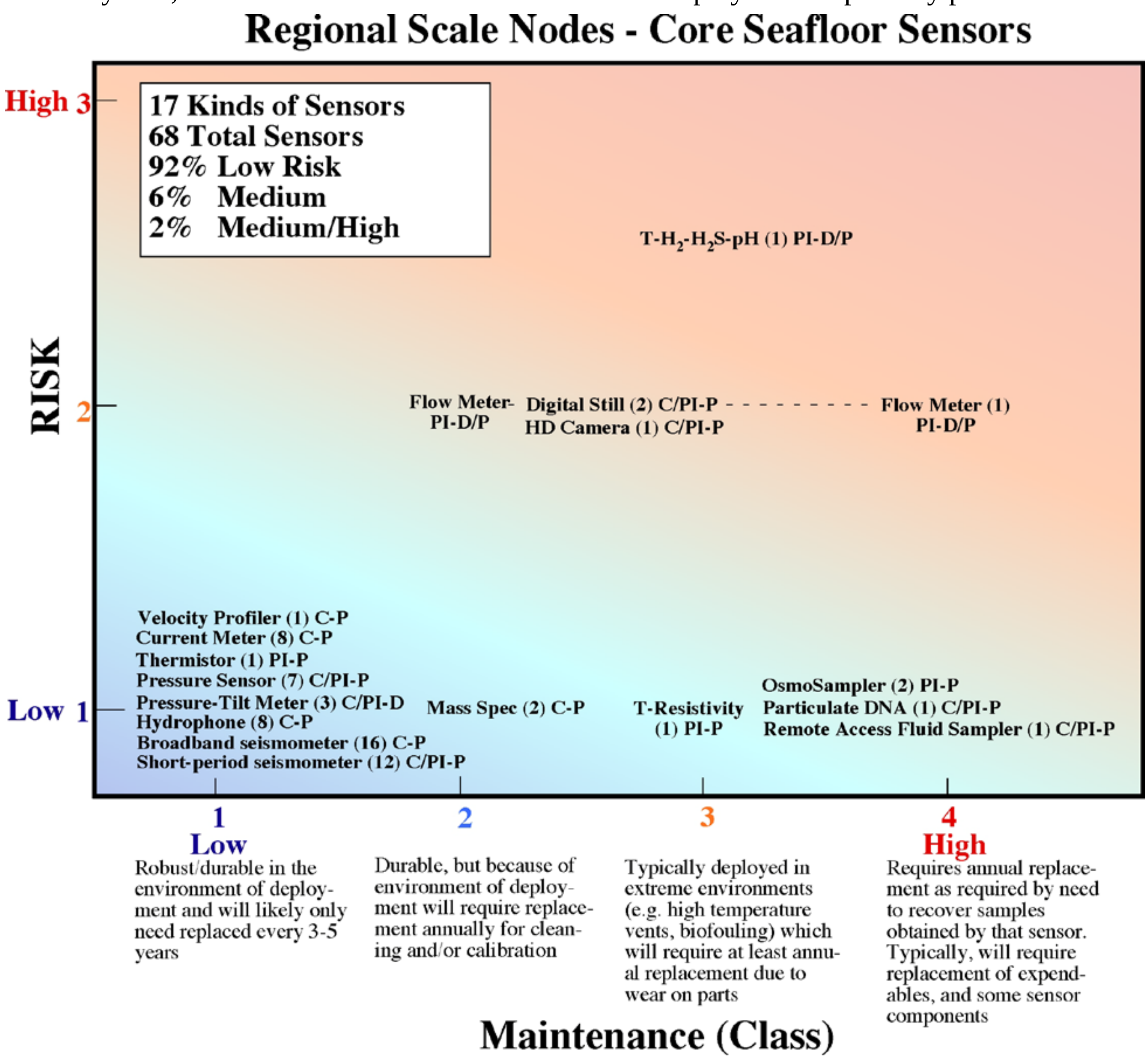

Figure 1. A comparison of class versus risk for core seafloor sensors on the RSN. This illustration shows that the core sensors are dominated by sensors that are low risk. C = commercial, PI = Individual investigator, P = proven, D = Developmental, (#) = number of sensors on the RSN.

robotic vehicle or submersible. Digital and video cameras have been used for many years at sites of venting and in gas hydrate systems in the Gulf of Mexico and are of proven technology. Typical deployment times, however, have been on order 1 week to a few months.

Installation-Redundancy: The cameras will be installed on a frame ~ 1 m above and away from the environmental sites of interest. Video cameras have been deployed at vent sites and at sites of gas seeps for 1-year duration before, but are susceptible to biofouling (microbial and macrofuana) and can serve as nucleation sites for gas hydrates. Routine operations will involve operation of the lights and cameras for several minutes, several times/day, but longer durations may be required when perturbations events occur. Investigation is underway to use LED lights instead of HMI's, which will increase the life expectancy on light sources-perhaps moving them into Class 2 sensors.

Maintenance and Spares: Cameras will require annual replacement due to biofouling, and light sources will likely require replacement. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

Risk and Mitigation: The digital still cameras are classified as Medium Risk because they will be deployed in an environment where biofouling is common. This biofouling can take the form of the progressive development of bacterial colonies and/or colonization by larger organisms. Initial mitigation will include replacement and cleaning of the camera annually. Significant research is ongoing into mitigation of biofouling in marine systems through nanotechnology with the development of nanofilms. This research may have applications to these sensors. In addition, wipers are now standard on some oceanographic sensors (e.g. fluorometers), and a similar system may be developed for cameras.

3.2. High definition Camera, Pan and Tilt, Strobe – Risk Medium, Class 2-3 (CC-CN-C):

This camera will provide high definition imagery of active black smoker chimneys and associated biota with transmission rates of > 1 Gb/sec at Axial Seamount and meets the science requirements to image plumes, vent sites, and associated biota (A4 and A6). Although HD cameras have not been deployed for long-periods of time, lower resolution video cameras have been deployed for periods of 1-year. The components are reliable. The components are commercial, but will require integration of the pan and tilt system. The camera is deployed and optimally placed with a robotic vehicle or submersible.

Installation-Redundancy: This camera will be deployed with pan and tilt capabilities on a frame ~ 1 m tall and ~ 1 m away from a high temperature black smoker in the Ashes Hydrothermal Vent Field on Axial Seamount. The camera has been used on ROV's in this setting. Routine operations will involve operation of the lights and camera for several minutes, several times/day, but longer durations may be required when perturbation events occur. Similar to the digital still camera, this sensor will also be susceptible to biofouling and will need cleaned every year. Investigation is underway to use LED lights instead of HMI's, which will increase the life expectancy on light sources-perhaps moving them into Class 2 sensors. LED lights are now commercially available at 250 watts with life times of 55,000 hrs.

Maintenance and Spares: Cameras will require annual replacement due to biofouling, and light sources will likely require replacement. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

Risk and Mitigation: The high definition camera is classified as Medium Risk because it will be deployed in an environment where biofouling is common. This biofouling can take the form of the progressive development of bacterial colonies and/or colonization by larger organisms. Initial mitigation will include replacement and cleaning of the camera annually. Significant research is ongoing into mitigation of biofouling in marine systems through nanotechnology with the development of nanofilms. This research may have applications to these sensors. In addition, wipers are now standard on some oceanographic sensors (e.g. fluorometers), and a similar system may be developed for cameras.

3.3. DNA particulate sampler (PPS-Preserved Particle Sampler) – Low Risk, Class 3-4 (CC-CN-C).

Preserved particle samplers are required to provide time-series sampling of microbial material for investigation of community species and distribution and changes in population through time and with fluid chemistry-temperature as outlined by the Science Requirements in A4. Coupling of this system with the Remote Access fluid Sampler (RAS) allows microbial data to be co-registered with fluid chemistry and temperature. One sampler will be deployed on the RSN. The bulk of the sampler is commercial, but modification for pumping of fixative and integration of this instrument package with the RAS is PI-specific. Material on the filters can be analyzed by t-RFLP techniques for DNA fingerprinting, which allows time-series measurements to be made that can document whether microbial community structure is stable over time. The package is deployed off of the side of a ship and free-falled to the seafloor,but will now be deployed via ROV. It is optimally placed at the experimental site by and ROV or submersible, and the sampling nozzle is then strategically placed in sites of flow.

Installation-Redundancy: This system will be coupled to a RAS at a site of diffuse flow in the ASHES Hydrothermal Field on Axial Seamount. The PPS will be deployed as part of a moored system with a sampling tube placed several meters away in the site of diffuse flow. Pumping of fluids over filters allows for 24 particulate DNA samples to be obtained. Sampling rates can be adjusted through in real-time. These systems are robust and have a several year history of annual deployments at hydrothermal sites at both Axial Seamount and the Endeavour Segment. Annual recovery of this system is required to obtain the preserved samples. Cleaning is required, as is replacement of filters, preservation solutions, and typically pumps need refurbished or replaced giving this sensor a Class 3-4 rating.

Maintenance and Spares: PPS units will require annual replacement of filters. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

Risk and Mitigation: The Remote Access Sampler has strong history of reliability in its ability to collect samples over 1-year duration in vent environments and is a Low Risk sensor. A new sensor will be deployed each year, and the recovered one will be cleaned, and refurbished as needed for deployment the follow-on year. It will be thoroughly tested and verified prior to deployment.

3.4. Benthic Flow Meter – Risk Medium, Class 2-4 (CN-C):

This system is a high resolution electronic flow meter for measuring flow rate across the sediment-seawater interface while at the same time collecting fluids for shore-based chemical analyses. It meets the requirement to measure fluid flow in and out of seep environments in at least one location as outlined in the Science User Requirements document A6. One sensor will be deployed at one of the seep sites at Hydrate Ridge. This is a PI-developed, fabricated and maintained sensor. The sensor is deployed with an ROV or submersible.

Installation-Redundancy: These sensors are placed in high-sedimented environments and require strong coupling to the seafloor (i.e. sensor head is partially buried in sediments). They have been used in Monterey Bay and on the acreetionary margin off of Vancouver Island. The components are durable, but the instrument will require annual recovery to refill the tracer dye reservoir and to recover the fluid samples for shore-based chemical analyses, giving the sensor a Class 2-4.

Maintenance and Spares: Benthic Flow units may require annual maintenance, depending on the technology deployed. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 unit for turns of each deployed unit (if annual maintenance necessary) and 1 spare.

Risk and Mitigation: Optical benthic flow meters are a relatively recent technology for the marine environment and so do not yet have a long history of deployment. Therefore, this sensor is a medium risk sensor. Mitigation of this risk includes the deployment of additional sensors in margin environments prior to installation of the RSN. This will provide additional development and testing of the sensor. A prototype will be thoroughly tested and verified.

3.5.Hydrophone – Low Risk, Class 1 (CC):

The wide bandwidth hydrophones meet the requirements laid out for investigation of earthquakes at local and plate scales because they provide essential support to secondary reception of p-waves from seismic events and they are also extremely valuable in the tracking of Blue whales vocalizations (<100 Hz). These sensors meet the requirements as outlined in the Science User Requirements A4, A5, and A6.

Installation-Redundancy: The sensors will be co-located with broadband instruments – sixteen hydrophones will be included on the RSN. They are easily deployed on the frame of the other sensors, and do not require any special treatment. They are very durable, and have been used routinely in the marine environment for years, giving them a Class 1 rating.

Maintenance and Spares: Hydrophones will be deployed for up to 5 years at a time. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 spare.

Risk and Mitigation: Hydrophones are Low Risk sensors. A prototype will be thoroughly tested and verified.

3.6. Mass Spectrometer – Low Risk, Class 2 (CC):

A total of two mass spectrometers will be on the RSN, one at a seep site at Hydrate Ridge, and a second at a vent site on Axial Seamount. These sensors meet the science requirements to obtain fluid-volatile chemistry in real-time to examine temporal changes associated with process such as earthquakes and injection of melt, and gas hydrate release as outlined in the A4 and A6 Science User Requirements. These sensors have been used on robotic and submersible vehicles, moorings and have recently been funded for deployment on autonomous vehicles.

Installation-Redundancy:
One sensor will be placed at a seep site on Southern Hydrate Ridge and another at Axial Volcano. They will be co-located with other chemical sensors and sensors for measuring temperature. The sensor will be deployed at the experimental site with an ROV or submersible. They have been used on various submarine platforms for year-long deployments but will require annual recovery for cleaning, and will require a co-registered fluid sample prior to deployment and subsequent to recovery giving them a Class 2 rating.

Maintenance and Spares: Mass Spec units will require annual maintenance, depending on the technology deployed. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

Risk and Mitigation: Mass spectrometers are Low Risk sensors. Commercial systems are now routinely deployed in the oil industry for long-term monitoring. A prototype will be thoroughly tested and verified. The sensor will be recovered and replaced annually to insure proper calibration.

3.7. Pressure-Bottom-Tilt Meter- Low Risk, Class 1 (CC-CN-C):

Three instrument packages with integrated bottom pressure sensors and tilt meters will be deployed in, and proximal to, the caldera on Axial Seamount to meet the science requirements to monitor eruptive cycles on a submarine volcano, inflation and deflation events that provide insight into pressure gradients resulting from injection of melt to shallow crustal reservoirs (A4 and A5). Tiltmeters have not been routinely used in submarine environments, but are commonly used in terrestrial systems and NSF has recently funded integration of these two sensors for deployment on the MARS testbed. The components are commercial but the integration requiring custom fabrication requires a PI.

Installation-Redundancy: Bottom pressure sensors have been routinely for long-term deployments on the seafloor. They have been deployed on Axial Seamount annually since 1998 and have successfully documented changes in inflation and deflation of the volcano. The integrated tilt-pressure sensor system will be deployed on the MARS test bed and so should be robust before deployment on the RSN. They require deployment procedures that insure that the sensor is level (placement of the pressure case into a pipe filled with glass microspheres) and coupling to the seafloor. This deployment is very similar to that routinely used for deployment of broadband seismometers. Individually the pressure sensors and tilt meters are very robust and this system should be very durable giving this a Class 1 rating. Because the pressure sensor measurements drift over time, annual visitation with a pressure sensor on an ROV or submersible will be required.

Maintenance and Spares: Pressure-Tilt units will be deployed for up to 5 years at a time. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 spare.

Risk and Mitigation: Pressure sensors have a proven history of reliable, long-term data return in submarine environments and are Low Risk. Measurements do drift during year-long deployments but this will be mitigated by annual visits with the ROV hosting an identical pressure sensor. Repeat pressure measurements over several minutes during routine maintenance visits will mitigate drift issues. The integrated tilt-pressure system will have a long deployment history on MARS. A prototype will be thoroughly tested and verified prior to deployment on the RSN.

3.8. Pressure Sensor – Low Risk, Class I (CC-CN-C):

Seven of these sensors will be deployed on the RSN – five at each of the primary node sites on the backbone of the cable, one at Southern Hydrate Ridge and one at the eastern Subduction Zone site. The sensors will meet the science requirements to measure changes in pressure associated with tides, and changes in topography and are important for understanding results from the broadband and short-period seismometers as well as a host of other sensors. These sensors meet the requirements as outlined in A4, A5 and A6. Because the crust acts as a porous sponge, seawater and hydrothermal fluids migrate into, and out of, the seafloor with the tides, resulting in correspond changes in temperature and vent fluid chemistry as well as expulsion of bubbles at seeps. The components are commercial, but the sensors need placed in titanium housings with oil-filled sensor housings.

Installation-Redundancy: Bottom pressure sensors have been routinely for year-long measurement of changing pressure at the seafloor associated with lunar tides, and inflation and deflation events. They have been deployed in hydrothermal vent fields and on submarine volcanoes. Except for drift, they are very durable making them a Class 1 sensor. An annual visitation with a pressure sensor on an ROV or submersible will be required.

Maintenance and Spares: Pressure Sensors will be deployed for up to 5 years at a time. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 spare.

Risk and Mitigation: Pressure sensors have a proven history of reliable, long-term data return in submarine environments and are Low Risk. They do drift during year-long deployments but this will be mitigated by annual visits with the ROV hosting an identical pressure sensor. Repeat pressure measurements over several minutes during routine maintenance visits will mitigate drift issues.

3.9. Broadband Seismometer – Low Risk, Class 1 (CC):

A broadband seismometer (≤ 4.2 mHz to >35 Hz) will be installed at all five backbone primary nodes, one will be installed at the summit of Southern Hydrate Ridge, 8 will be installed as two arrays along the Blanco Fracture Zone, two up on the summit of Axial Seamount, and one at the Eastern Subduction Zone site to meet the requirements as outlined in A4, A5, and A6. The broadband seismometers deployments will be the first in the worlds oceans to instrument all three boundaries on a single tectonic plate, as well as mid-plate allowing unprecedented insights into seismicity at a plate scale and its impacts on crustal deformation, hydrogeology, and impacts on hydrothermal chemistry and biota. The broadband seismometers are buried in caissons and covered with silica microspheres for optimal coupling to the seafloor. They are deployed and recovered by an ROV. The components are commercial, but will need placed in titanium housings for long-term durability. Some commercial companies provide this modification.

Installation-Redundancy: There is now precedence for long-term deployment of seismometers buried in ocean basins and they have routinely been used for periods of 1-year to several months at mid-ocean ridge spreading centers. These sensors, once deployed, should be very robust making them a Class 1 sensor. Multiple redundant sensors will be required early on, however, because if a sensor fails, calibration in vaults of several months is required for new sensors. Hence, the need to have replacement sensors.

Maintenance and Spares: Seismometers will be deployed for up to 5 years at a time. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 spare.

Risk and Mitigation: Broadband seismometers have a along history of use in marine environments and are a Low Risk sensor. Broadband sensors will have a several year history of use on the Neptune Canada system prior to installation of OOI core sensors on the RSN. The sensors will be thoroughly tested and verified prior to deployment

3.10. Short-period Seismometers – Class 2 (CC-CN-C):

Twelve short-period seismometers (≤1 to >100 Hz) will be installed on the RSN to investigate local seismicity associated with large scale crustal faulting, localized faulting due to fluid movement, microearthquakes associated with hydrothermal vent environments and gas hydrate dissolution and migration of methane gas. To meet the Science User Requirements outlined in A4, A5, and A6, three short-period seismometers will be deployed at the Summit of Southern Hydrate Ridge, six at Axial Seamount in the caldera and around the ASHES vent field, and three at the Eastern Subduction Zone Site. The components of the seismometers are commercially available, but their incorporation into titanium housings and the requirement for LED lights to indicate that they are deployed within ±2-5° of level require special fabrication by a PI. MBARI has made numerous sensors that have these capabilities.

Installation-Redundancy: Long-term deployment (3 years) of short-period seismometers has been highly successful at the Endeavour Segment of the Juan de Fuca Ridge both in drill holes in basaltic substrate as well as in seismonuments. They are durable and should only need replaced every 3-5 years making them a Class 1 sensor.

Maintenance and Spares: Seismometers will be deployed for up to 5 years at a time. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 spare.

Risk and Mitigation: Short-period seismometers have a along history of use in marine environments and are a Low Risk sensor. Short-period sensors will have a several year history of use on the Neptune Canada system prior to installation of OOI core sensors on the RSN. The sensors will be thoroughly tested and verified prior to deployment

3.11. Temperature-H_2-H_2S-pH – Class 3 (CN-C):

One of these sensors will be deployed in a black smoker orifice in the ASHES hydrothermal field at Axial Seamount on the Juan de Fuca Ridge. They provide in-situ monitoring of rapid (< 5 minute) and long-term (days) changes in temperature and corresponding vent fluid chemistry. These parameters provide important insights into chemical conditions in subseafloor reactions zones and important information of key volatiles for life (hydrogen and hydrogen sulfide) in extreme environments. These environmental parameters change rapidly due to both seismic and magmatic events and are strongly impacted by phase separation in the fluids. This sensor meets the Science User Requirements laid out in A4 and A5 and one of these sensors will be. Because the sensors are deployed in high temperature, high pressure and acidic environments there is no commercial product available.

Installation-Redundancy: These sensors have been deployed short-term in black smoker environments on the East Pacific Rise, on the Endeavour Segment at the Juan de Fuca Ridge. They continue to be used in submarine environments, most recently deployed in the Lost City Hydrothermal Field in summer 2008. The tips of these sensors are deployed directly down the throats of black smoker chimneys, such that their tips may not survive an entire year. Part of this will depend on if the chimneys grow around the sensors, protecting their heads. Because of this they are designated a Class 3 sensor. Gas tight fluid samples will be required before deployment and immediately after recovery of these sensors.

Maintenance and Spares: High Temp-**H_2-H_2S-pH** will be examined annually, and if operating correctly will be left in place. Advancements in this instrument may necessitate annual replacement. Maintenance will consist of replacement of any outdated components. Sparing will consist of 1 turn and 1 spare.

Risk and Mitigation: These sensors have not been deployed for 1-year durations in black smoker vents, but have been deployed for < 1 month periods. Therefore, these are Medium-High Risk sensors. This sensor package uses electrodes of different materials (e.g. Yittria-stabilized zirconia for pH), which should hold up well in the vent environments. However, they do not yet have a long documented history. The mitigation for this sensor is to replace it annually.

3.12. Temperature-Resistivity Probe – Class 3 (CN-C):

One temperature-resistivity sensor will be deployed in a black smoker in the ASHES hydrothermal field on Axial Seamount to investigate rapid (< 1 minute) and long-term (1 year or longer) changes in the temperature and chlorinity of vent fluids to meet Science User Requirements outline in A4 and A5. Chlorinity is strongly impacted by boiling and condensation of brines in submarine systems (an extremely common phenomena), governs metal complexing, and may be important for microorganisms in the subsurface that require very high salt concentrations (>20 wt 5). Because the sensors are deployed in high temperature, high pressure and acidic environments there is no commercial product available. One of these sensors will be placed on NEPTUNE Canada at Endeavour.

Installation-Redundancy: These sensors have been deployed for several months in black smokers on the East Pacific Rise, and for a year (several times) in smokers on the Endeavour Segment at the Juan de Fuca Ridge. They can be quite durable – i.e. they have worked numerous times for 1 year in black smokers on the Endeavour, where they were recovered because of the necessity to change out their batteries. The tips of these sensors are deployed directly down the throats of black smoker chimneys, such that their tips may not survive an entire year, however. Part of this will depend on if the chimneys grow around the sensors, protecting their heads. Because of this uncertainty, to be conservative they are designated a Class 3 sensor. Gas tight fluid samples will be required before deployment and immediately after recovery of these sensors.

Maintenance and Spares: High Temp-Resistivity will be examined annually, and if operating correctly will be left in place. Advancements in this instrument may necessitate annual replacement. Maintenance will consist of replacement of any outdated components. Sparing will consist of 1 turn and 1 spare.

Risk and Mitigation: The temperature-resistivity sensors are a Low Risk sensor with a proven history of year-long deployments in vents. The dynamic nature of the vents, however, means that vent orifices may change locations, so to mitigate this possibility in environmental change these sensors will be replaced annually if needed.

3.13. Thermistor arrays – Class 1 (CC-PI):

One thermistory array will be deployed in a biologically-active diffuse flow site in the ASHES hydrothermal field on Axial Seamount to investigate corresponding changes in thermal conditions, micro- and macrofuanal community distribution and fluid chemistry. This sensor meets Science User Requirements in A4 and A5. Although the components are readily available commercially, integration of several thermistors into an array is only available through special fabrication.

Installation-Redundancy: These sensors have been deployed for long durations in diffuse flow sites on the Endeavour Segment of the Juan de Fuca Ridge and at other sites of flow. They are a technologically simple sensor package and are robust making them a Class 1 sensor.

Maintenance and Spares: Thermistor Arrays will be examined annually, and if operating correctly will be left in place. Maintenance will consist of replacement of any failed components. Sparing will consist of 1 spare.

Risk and Mitigation: Thermistors are very simple sensors that have a history of being deployed in vent environments. They are Low Risk. Sensors will be visually checked annually to insure proper placement in areas of diffuse flow.

3.14. Current Velocity Meters – Class 1 (CC):

Current meters will be deployed at all backbone Primary Node sites on the RSN (5), and one each at the summit of Axial Seamount, Southern Summit of Hydrate Ridge and the Eastern Subduction Zone site to meet Science User Requirements outlined in A4, A5, and A6. They are important sensors to measure real-time changes in current direction and velocity, which impact the chemistry of vent fluids, and can create acoustic noise that impacts seismicity measurements. These sensors are routinely available commercially and have temperature sensors incorporated into their housings.

Installation-Redundancy: Current meters have been routinely deployed for long-term measurements (1-year) in hydrothermal vent fields on the Juan de Fuca year. They are mounted on ~ 1 m tethers and are easily deployed by an ROV or submersible. Traditionally, they have been recovered because of the need to swap out batteries. They are robust, making them a Class 1 sensor.

Maintenance and Spares: Current Meters will be examined annually, and if operating correctly will be left in place. Maintenance will consist of replacement of any failed units. Sparing will consist of 1 spare.

Risk and Mitigation: Current meters have a long, documented history of deployment in seafloor and vent environments. They are Low Risk. Visual inspection will occur annually to insure that no biofouling has occurred. Sensors will be recovered and replaced as needed.

3.15. Velocity Profiler – Class 1 (CC):

One 75 kHz acoustic doppler current profiler will be deployed in an upward-looking position on the seafloor at the summit of Southern Hydrate at an active seep to image the methane-rich plume. This sensor meets the requirements laid out in the Science User documents A5 and A6. The profiler will be acquired from a commercial source, although a seafloor-mount will need to be manufactured by the RSN IO.

Installation-Redundancy: These sensors are routinely deployed in marine environments, and are durable. The sensor may need brought to the surface annually to clean biofouling, but they are durable giving it a Class 1 rating. They do not require calibration often, but potentially each 3 years. The sensor can be deployed with and ROV or submersible. The aluminum housing presents a potential corrosion failure.

Maintenance and Spares: ADCPs will be examined annually, and if operating correctly will be left in place. Manufacturers suggest re-calibration and refurbishment on a 3-year cycle. Maintenance will consist of replacement of any failed units. Sparing will consist of 1 spare.

Risk and Mitigation: ADCP's have a documented history of use in marine environments. There are no moving parts and the sensors are Low Risk. Sensors will be annually inspected during routine maintenance of the system.

3.16. OsmoSampler – Class 4 (CN-C):

To meet the Science User Requirements outlined in A4, A5 and A6 to make time-series measurements at a vent and seep site, two OsmoSamplers will be deployed at the ASHES vent field on Axial Seamount on the Juan de Fuca Ridge and at the summit of Southern Hydrate Ridge. A temperature sensor is coupled to the intake tube for co-registered temperature measurements. The sampler and temperature probes are not commercially available.

Installation-Redundancy: OsmoSamplers are routinely deployed in high- and low-temperature venting environments, and in CORKED observatories in drill holes. They are very durable and are easily deployed with and ROV or submersible. They can be deployed for a few years at a time, but temporal sampling requirements mean that this system will need to be recovered annually so that vent and seep fluid samples can be analyzed for major and trace element fluid chemistry on shore making them a Class 3-4 sensor. A major sampler should be taken prior to deployment and subsequent to recovery.

Maintenance and Spares: OSMO will be retrieved annually and replaced annually. Maintenance will consist of replacement of internal tubing. Sparing will consist of 1 turn and 1 spare.

Risk and Mitigation: OsmoSamplers do not have moving parts, but use osmosis to draw in vent fluids into capillary tubes. The associated temperature sensors are routinely used in vent environments. This system is Low Risk.

3.17. Remote Access Water Sampler (RAS) – Class 3-4 (CC-CN-C):

One RAS will be deployed in the ASHES vent field at Axial Seamount on the Juan de Fuca Ridge to meet fluid sampling requirements described in Science User documents A4 and A5. The RAS allows 48, 800 ml fluid samples to be recovered from a diffuse flow site for follow-on shore-based chemical analyses. It plays an important role in examining the linkages between temperature, hydrothermal flow, seismic and volcanic activity and the impact that these processes have on subseafloor biological communities over time. Real-time communications will allow changes to be made in the sampling regime in response to monitored environmental parameters. The RAS is commercially produced, but the system is modified with sensors (H_2S. temperaure, pH) at the intake nozzle and addition of an acid reservoir for flushing of the line.

Installation-Redundancy: These systems have a long history of deployment at hydrothermal vent sites on Endeavour and at Axial Seamount and they are durable systems. They are deployed coupled to the PPS on a mooring with an acoustic release and pull pin, with an ~ 30 m line attached to glass floats to keep the system upright. The system is deployed off of the side of a ship and allowed to free-fall to the seafloor. The entire package is moved into place with an ROV and the intake nozzle is placed in an optimal site of diffuse flow. The system is robust and has been shown to work for a period of one year during numerous deployments. The sensors at the intake may need switched out annually, and the system must be recovered annually to analyze the fluids in shore-based labs. Major fluid samples should be taken prior to deployment and after recovery making this a Class 3-4 system.

Maintenance and Spares: PPS units will require annual recovery of the sampled fluids and their analysis. Maintenance will consist of cleaning checkout of operation and replacement of any failed components. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

Risk and Mitigation: The RAS has a documented history of year-long deployments in vent environments and is Low Risk. The system requires annual recovery to processes fluid samples for chemistry. Complete replacement of the system will mitigate possible failure of pumps and other system components.

4. Water Column (Hybrid Mooring) Sensors

This section describes additional sensors unique to the water column on the hybrid mooring of the RSN system, the anticipated maintenance needs that drive redundancy requirements, and the number of redundant sensors anticipated to be required, as well as spares. The total number of different kinds of water column sensors on the RSN totals 17 of which 7 are Class 1 sensors. The camera, ADCP and ACM were described in section 3, above. A summary table (Table 2) can be found at the end of the document.

Assumptions:

- The entire suite of RSN sensors have been deployed and are operational.
- This covers only sensors on the RSN.

4.1. Conductivity, Temperature, Depth (CTD) Sensor - Class 2-3 (CC).

This type of sensor has been deployed for over 50 years in a variety of manners and for long deployments. The temperature and depth sensors are very robust, however the conductivity cell is subject to fouling. Because of this, the instrument is subject to drift and must be recalibrated regularly. The main area of fouling is motion through the air-water boundary where natural oils and material accumulate. As the RSN shallow profiler will have no surface expression, this mechanism of fouling will be minimized.

Installation-Redundancy: The CTDs will be installed on the platform and both the shallow deep profilers as well as the bottom package. Testing by Neptune Canada revealed expected biofouling in the upper mixed layer, minimizing at 200m to near bottom and an increase of hydroids at the bottom. RSN can then expect a similar type fouling with the shallow profiler and bottom package experiencing the most fouling.

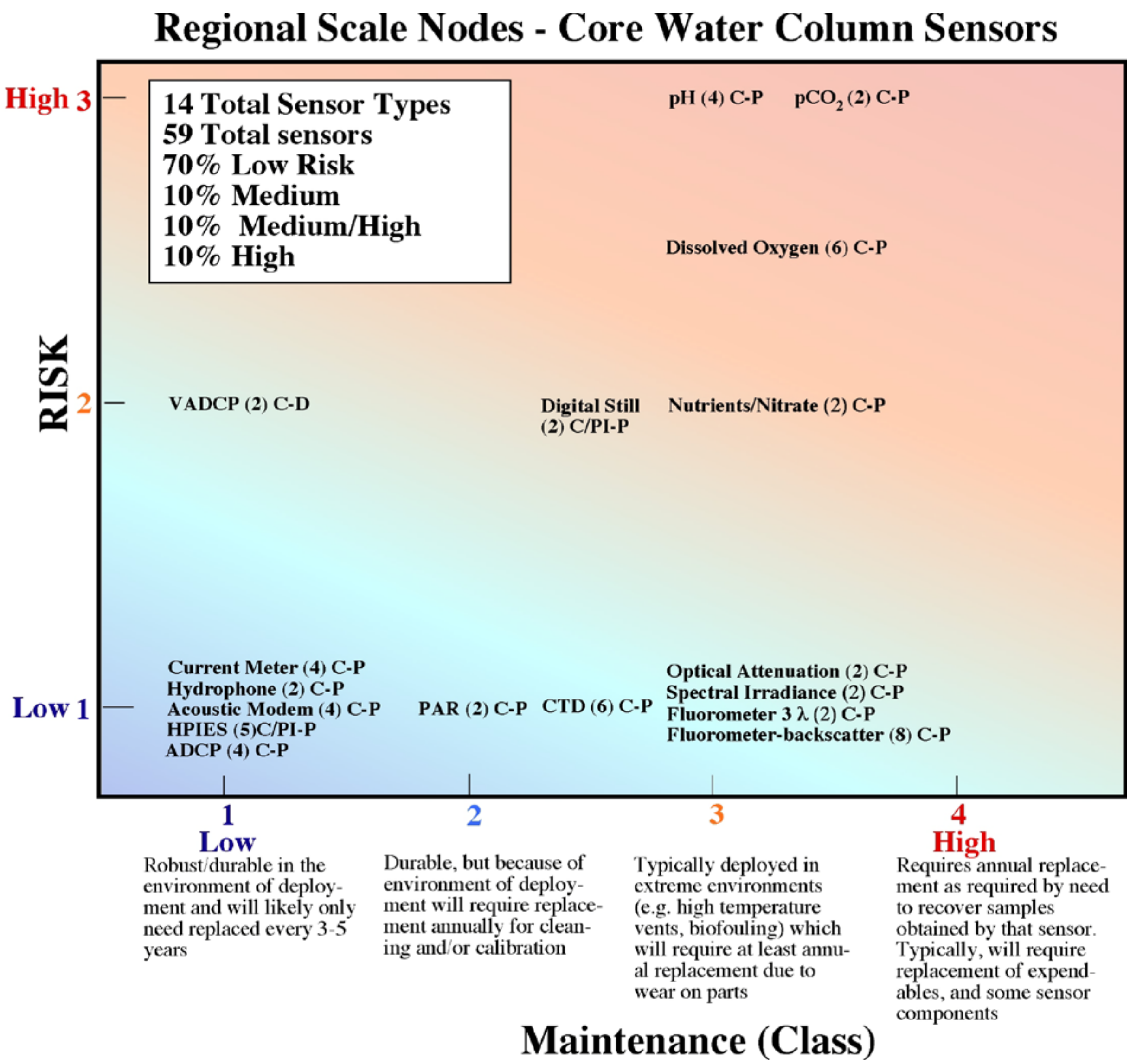

Figure 2. A comparison of class versus risk for core water column sensors on the RSN. This illustration shows that the core sensors are dominated by sensors that are low risk. C = commercial, PI = Individual investigator, P = proven, D = Developmental, (#) = number of sensors on the RSN.

4.2. Fluorometer – 3 Wavelengths (3W) - Class 3 (CC).

This Flurometer measures scattering oflight in segments of the water column in 3 narrow optical bands. It is mounted on the shallow profiler to obtain the vertical profiles. It is a commercial instrument that is stable and has been used for long deployments. It will require cleaning and annual recalibration.

Installation-Redundancy: Flurometer sensors will be deployed on the shallow profiler of both hybrid moorings. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel for annual maintenance. The device will be cleaned and checked and only replaced if necessary. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: 3W Fluorometers units will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.3. Fluorometer – Optical BackScatter (OBS) - Class 3 (CC):

Optical Backscatter (OBS) measures turbidity by absorption of light in small segments of the water column narrow optical bands. It is mounted on the shallow profiler to obtain the vertical profiles. It is a commercial instrument that is stable and has been used for long deployments. It will require cleaning and annual recalibration.

Installation-Redundancy: OBS sensors will be deployed on the shallow profiler of both hybrid moorings. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel for annual maintenance. The device will be cleaned and checked and only replaced if necessary. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: Optical Backscatter units will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.4.Nutrients, Nitrate - Class 3 (CC).

Nitrate is a critical nutrient that is measured by absorption of light in small segments of the water column narrow optical bands. It is mounted on the shallow profiler to obtain the vertical profiles. It is a commercial instrument that is stable and has been used for long deployments. It will require cleaning and annual recalibration.

Installation-Redundancy: Nitrate sensors will be deployed on the shallow profiler of both hybrid moorings. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel for annual maintenance. The device will be cleaned and checked and only replaced if necessary. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: Nitrate sensors units will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.5. Optical Attenuation - Class 3 (CC):

Optical Attenuation measures the absorption of light in small segments of the water column narrow optical bands. It is mounted on the shallow profiler to obtain the vertical profiles. It is a commercial instrument that is stable and has been used for long deployments. It will require cleaning and annual recalibration.

Installation-Redundancy: Spectral Irradiance sensors will be deployed on the shallow profiler of both hybrid moorings. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel for annual maintenance. The device will be cleaned and checked and only replaced if necessary. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: Optical Attenuation units will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.6. pH - Class 3 (CC).

pH sensing is a critical component of upper-ocean mixing and indicator of biological potential and global warming. The sensors are commercially produced and stable for up to one year with drift. It will be helpful to externally measure pH on retrieval to document instrument drift. They will require maintenance and recalibration annually. The sensor is deployed as part of the suite of instruments on the shallow profiler of both hybrid moorings.

Installation-Redundancy: pH sensors require annual maintenance and recalibration. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel where the suite of instruments will be exchanged. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: pH instruments will require annual maintenance and calibration, per manufacturers, and potentially refilling of reagents. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.7. Spectral Irradiance - Class 3 (CC):

Spectral Irradiance measures solar radiation in narrow bands as it progresses thru the water column. It is mounted on the shallow profiler to obtain the vertical profiles. It is a commercial instrument that is stable and has been used for long deployments. It will require cleaning and annual recalibration.

Installation-Redundancy: Spectral Irradiance sensors will be deployed on the shallow profiler of both hybrid moorings. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel for annual maintenance. The device will be cleaned and checked and only replaced if necessary. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: Spectral Irradiance instruments will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.8. Photosynthetically Active Radiance (PAR) - Class 2 (CC).

PAR sensors will be deployed as a 2-pi steradian upward-looking optical sensors that measure the available solar radiation available for phytoplankton and algae. The instrument will be deployed on the shallow profilers to obtain vertical distributions of specific bandwidths (400-700nm) of light. Both hybrid moorings of RSN will have these sensors. The instrument will need cleaning at least annually to remove fouling. These instruments are commercially produced, stable and have been used for decades in oceanographic research.

Installation-Redundancy: PAR sensors will be deployed on the shallow profiler of both hybrid moorings. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel for annual maintenance. The device will be cleaned and checked and only replaced if necessary. A single spare is required for expected occasional failures.

Maintenance and Spares: PAR instruments will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.9. pCO_2 - Class 3 (CC):

CO2 movement and exchange in the water column is a critical component of upper-ocean mixing and indicator of global warming. The sensors are commercially produced and stable for up to one year with minimal drift. They will require maintenance annually to replace reagents and recalibration. The sensor is deployed as part of the suite of instruments on the shallow profiler of both hybrid moorings.

Installation-Redundancy: pCO2 sensors require annual maintenance and recalibration. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel where the suite of instruments will be exchanged. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: pCO_2 instruments will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.10. Dissolved Oxygen (DO) - Class 3 (CC).

Dissolved Oxygen sensing is a critical component of upper-ocean mixing and indicator of biological potential. The sensors are commercially produced and stable for up to one year with minimal drift. They will require maintenance annually. The sensor is deployed as part of the suite of instruments on the shallow profiler of both hybrid moorings.

Installation-Redundancy: DO sensors require annual maintenance and recalibration. The shallow profiler will be serviced by bringing it on deck of a UNOLS vessel where the suite of instruments will be exchanged. A swappable, calibrated instrument will be necessary to maintain continuous data collection.

Maintenance and Spares: Dissolved Oxygen instruments will require annual maintenance and calibration, per manufacturers. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 unit for turns of each deployed unit and 1 spare.

4.11. Broadband Hydrophone - Class 1 (CC):

This sensor (acoustic current meter) measures water current at its location. ACMs have been deployed for long-periods of time at near surface to ocean bottom locations. The components are reliable. The components are commercial, but will require placement into titanium pressure housings and fabrication of frames. The sensor is deployed and optimally placed with a robotic vehicle or submersible or during surface maintenance of the shallow profiler.

Installation-Redundancy: This current meter will be deployed off of platforms and both shallow and deep profilers on both moorings. It is expected to operate with minimal maintenance throughout its deployment, with possible cleaning to remove any biofouling. It can be serviced via ROVs and submersibles.

Maintenance and Spares: Hydrophones will require annual inspection, but are expected to remain in place for at least 5 years. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 spare.

4.12. Acoustic Modem (ACOMM) - Class 1 (CC).

Acoustic modems will be utilized to expand the horizontal extend of RSN by providing a link to mobile assets such as AUVs. These are commercial devices that have been used for decades in oceanographic research and the oil industry to activate equipment releases and low rate data transfer. In the past few years better signal processing techniques and miniaturization of electronics has increased the useful bandwidth to extend the communication aspect of the device.

Installation-Redundancy: ACOMMs will be installed on the platform and bottom packages of both moorings. These devices are stable and require little maintenance. They can be placed and maintained by ROVs and submersibles.

Maintenance and Spares: ACOMM will require annual inspection, but are expected to remain in place for at least 5 years. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 spare.

4.13. Vertical Beam Profiling Current Meter (VADCP) - Class 1 (CC):

One 600 kHz acoustic doppler current profiler with an added vertical beam will be deployed in an upward-looking position on the platform of each hybrid mooring at both volcano and seep sites to monitor upper ocean mixing due to these active sites. This sensor meets the requirements laid out in the Science User documents A5, A6 and A7. The profiler will be acquired from a commercial source, although it is a one-off modification and only one other instrument like this has been built.

Installation-Redundancy: These sensors are routinely deployed in marine environments, and are durable. The sensor may need brought to the surface annually to clean biofouling, but they are durable giving it a Class 1 rating. They do not require calibration. The sensor can be deployed with and ROV or submersible.

Maintenance and Spares: VADCP will require annual inspection, but are expected to remain in place for at least 3 years. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 spare.

4.14. Volume Averaged Currents (HPIES) - Class 1 (CCI):

This sensor measures the gravest mode average water currents of the water column by measuring the horizontal electric field (H) associated with polar molecules. It includes an inverted echo-sounder (IES). HPIES have been deployed for long-periods of time at ocean bottom locations with successful recoveries. The components are reliable modifications of commercial products, but will require placement away from other sources of electric fields to avoid signal contamination. The sensor is deployed and optimally placed with a robotic vehicle or submersible.

Installation-Redundancy: This current meter will be deployed on the bottom at both moorings at least 500m away from any sea water grounds. The IES component can be contaminated by the ADCP and can contaminate the broadband hydrophone. It is expected to operate with minimal maintenance throughout its deployment, with possible cleaning to remove any biofouling. It can be serviced via ROV.

Maintenance and Spares: HPIES will require annual inspection, and potentially annual replacement. They are expected to operate, initially, on batteries with a 1-2 year life. Maintenance will consist of cleaning checkout of operation and replacement of any failed components and re-calibration. Sparing will consist of 1 spare.

Table 1. Seafloor Sensor Redundancy and Classification

Unique Name/Name	Cost	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Turns #	Spare	Spares Cost	Class Justification
Camera-digital-still-strobe* Ethernet Camera	$55,000	1		1			2	2	1	$165,000	Class 2-3: Cleaning with likely replacement of light source
Camera-digital-video-HD* HD Camera	$90,000			1			1	1	1	$180,000	Class 2-3: Cleaning with likely replacement of light source; $90K is for lights, pan-tilt, sensor donated
DNA-particulate* PPS	$40,000			1			1	1	1	$80,000	Class 3-4: Annual, requires recovery of filters
Flow-benthic* Flow meter	$100,000	1					1	1	1	$200,000	Class 2-4: Annual swap for calibration, recovery of samples
Hydrophone-BB-passive* Hydrophone-Broadband	$10,092	2		3			4	0	1	$10,092	Class 1: Durable 5 years
Mass-spectrometer* Mass Spectrometer	$65,000	1		1			2	2	1	$195,000	Class 2: Will require cleaning, calibration with co-registered samples.
Pressure-bottom-tilt* BPR-tilt	$80,000			3			3	0	1	$80,000	Class 1: Durable 3-5 years. Pressure sensor drift will require visit by ROV

Unique Name/Name	Cost	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Turms #	Spares	Spares Cost	Class Justification
Pressure-SF-tidal* Pressure	$35,000	2		1			3	0	1	$35,000	Class 1: Durable 3-5 years. Pressure sensor drift will require visit by ROV
Seismometer-BB-triaxial-accel* Broadband Seismometer	$100,000	1		2			6	0	2	$200,000	Class 1: Durable 3-5 years. Note ~8 mo turn a-around if require calibration in vault.
Seismometer-BB-triaxial-keck* Broadband Seismometer	$30,000.00	1		1			2	0	0	$0.00	Class 1: Durable 3-5 years; Redundant sensors accounted for above; $30K for transition costs onto cable
Seismometer-shortperiod* Short Period Seismometer	$30,000	3					6	0	2	$90,000	Class 1: Durable 3-5 years
Seismometer-shortperiod-keck* Short Period Seismometer	$5,000			6			6	0	0	$0.00	Class 1: Durable 3-5 years; $5K is for transition of donated, redundant instruments moved above
Temp-H_2-H_2S-pH* T-H_2-H_2S-pH	$20,000			1			1	1	1	$40,000	Class 3: Deployed in >300°C vent; requires calibration fluid sample
Temp-resist* T-R	$45,000			1			1	1	1	$90,000	Class 3: Deployed in >300°C vent; requires calibration fluid sample
Temperature-seafloor* Thermistor Array	$30,000			1			1	1	1	$60,000	Class 1: Durable 3-5 years

Unique Name/Name	Cost	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Turns #	Spares	Spares Cost	Class Justification
Velocity-point-3D-turb Current Meter + Temperature	$14,000	2		2			6	0	2	$28,000	Class 1: Durable 3 years
Velocity-profile-600m ADCP	$65,000	1					1	0	1	$65,000	Class 1: Durable 3 years
Watersample-chem-trace* OSMO	$15,000	1		1			2	2	1	$30,000	Class 4: Durable but requires recovery for samples
Watersample-chem-trace-H_2S-pH* RAS	$70,000			1			1	1	1	$140,000	Class 3-4: Annual, requires recovery of filters
Total							**68**	**13**	**20**	**$1,453,092**	

Table 2. Water Column Sensor Redundancy and Classification

Unique Name/Name	Cost	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Turns #	Spares	Spares Cost	Class Justification
Camera-digital-still-strobe* Ethernet Camera	$55,000	2		2			2	2	1	$110,000	Class 2-3: Cleaning with likely replacement of light source

Unique Name/Name	Cost	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Turns #	Spares	Spares Cost	Class Justification
Flourometer – 3 wavelengths	$13,905	2		2			6	6	2	$111,240	Class 3: Cleaning with likely replacement of light source; factory recommends rebuild - swap
Dissolved Oxygen	$5,000	4		4			8	8	4	$60,000	Class 3: Annual factory recommends rebuild - swap.
Flurometer – Optical Backscatter	$4,600	4		4			8	8	4	$55,200	Class 3: Annual factory recommends rebuild - swap
Hydrophone-BB-passive* Hydrophone-Broadband	$10,000	2	0	2			4	0	1	$10,000	Class 1: Durable 5 years
CTD	$10,300	4		4			8	8	4	$123,600	Class 2: Will require cleaning, calibration via comparison – replace as necessary.
Nitrate	$34,000	1		1			2	2	1	$102,000	Class 3: Annual rebuild - swap
pH	$4,100	2		2			4	4	2	$24,600	Class 3: requires annual cleaning, recalibration
Optical Attenuation	$17,500	1		1			2	2	1	$52,500	Class 3: requires annual factory maintenance
Spectral Irradiance	$7,700	1		1			2	2	1	$23,100	Class 3: requires annual factory maintenance
PAR	$3,625	1		1			2	2	1	$10,875	Class 3: requires annual factory maintenance
pCO_2	$18,500	1		1			2	2	1	$55,500	Class 3: requires annual factory maintenance

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Unique Name/Name	Cost	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Turns #	Spares	Spares Cost	Class Justification
ADCP	$60,000	2		2			4	0	1	$60,000	Class 1: durable
VADCP	$65,000	1		1			2	0	1	$65,000	Class 1: durable
Acoustic Modem	$9,188	2		2			4	0	1	$9,188	Class 1: durable
Point Current Meter (ACM) + Temperature	$17,200	2		2			4	0	1	$17,200	Class 1: durable
Volume Averaged Current (HPIES)	$50,000	1		1			2	2	1	$150,000	Class 1: durable
Totals:		30		30			**60**	**48**	**28**	**$1,040,003**	

Table 3. Seafloor Sensor Classification and O&M FTE

Unique Name/Name	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Redudnant #	Class Justification	O&M FTE (months)	Justification
Camera-digital-still-strobe* Ethernet Camera	1		1			2	2	Class 2-3: Cleaning with likely replacement of light source	1	Check image quality, interface with CI; some classification
Camera-digital-video-HD* HD Camera			1			1	1	Class 2-3: Cleaning with likely replacement of light source; $90K is for lights, pan-tilt, sensor donated	2	Check image quality, interface with CI; some classification; downgrade some imagery to web quality
DNA-particulate* PPS			1			1	1	Class 3-4: Annual, requires recovery of filters	5	Conduct preliminary screening of DNA – tRFLP (3.5 mo analyses; 1 mo supplies and analytical costs; 0.5 mo at sea)
Flow-benthic* Flow meter	1					1	1	Class 2-4: Annual swap for calibration, recovery of samples	2.5	0.5 Monitor sensor, 1 mo for analyses, 1 mo for supplies and analytical costs
Hydrophone-BB-passive* Hydrophone-Broadband	2	1	2	2	1	8	6	Class 1: Durable 5 years	1	Monitor sensors, interface with CI
Mass-spectrometer* Mass Spectrometer	1		1			2	2	Class 2: Will require cleaning, calibration with coreg. samples.	2	1.5 mo Monitor sensor, interface with supplier, 0.5 at sea
Pressure-bottom-tilt* BPR-tilt			3			3	2	Class 1: Durable 3-5 years. Pressure sensor drift will require visit by ROV	1	0.5 mo monitor sensor, 0.5 interface with IO to ready sensor

Unique Name/Name	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Redudnant #	Class Justification	O&M FTE (months)	Justification
Pressure-SF-tidal* Pressure	2	1	1	2	1	7	4	Class 1: Durable 3-5 years. Pressure sensor drift will require visit by ROV	1	Monitor sensor, update calibration
Seismometer-BB-triaxial-accel* Broadband Seismometer	1	1	1	1	1	5	6	Class 1: Durable 3-5 years. Note ~8 mo turn a-around if require calibration in vault.	3	Monitor sensors, interface with CI and IRIS, check picks, 1 mo vault calibration, 0.5 mo at sea
Seismometer-BB-triaxial-keck* Broadband Seismometer	1	8	1	1		11	0	Class 1: Durable 3-5 years; Redundant sensors accounted for above; $30K for transition costs onto cable		
Seismometer-shortperiod* Short Period Seismometer	3			3		6	6	Class 1: Durable 3-5 years	3	Monitor sensors, interface with CI and IRIS, check picks, 0.5 mo at sea
Seismometer-shortperiod-keck* Short Period Seismometer			6			6		Class 1: Durable 3-5 years; $5K is for transition of donated, redundant instruments moved above		
Temp-H_2-H_2S-pH* T-H_2-H_2S-pH			1			1	1	Class 3: Deployed in >300°C vent; requires calibration fluid sample	2	Monitor sensor, analyze calibration fluid, 0.5 mo at sea
Temp-resist* T-R			1			1	1	Class 3: Deployed in >300°C vent; requires calibration fluid sample	2	Monitor sensor, analyze calibration fluid, 0.5 mo at sea
Temperature-seafloor* Thermistor Array			1			1	1	Class 1: Durable 3-5 years	1	Monitor sensor
Velocity-point-3D-turb Current Meter + Temperature	2	1	2	2	1	8	6	Class 1: Durable 3 years	1	Monitor sensor
Velocity-profile-600 m ADCP	1					1	1	Class 1: Durable 3 years	1	Monitor sensor

Unique Name/Name	RSN Hydrate	RSN Blanco	RSN Axial	RSN Subduction	RSN Midplate	RSN Total	Redudnant #	Class Justification	O&M FTE (months)	Justification
Watersample-chem-trace* OSMO	1		1			2	2	Class 4: Durable but requires recovery for samples	3	Monitor sensor (t) 0.5 mo; 1.5 mo analyses, 1 mo supplies & analyses
Watersample-chem-trace-H_2S-pH* RAS			1			1	1	Class 3-4: Annual, requires recovery of filters	4	1 mo monitor sensors, 1 mo analyses, 1.5 mo supplies analytical costs , 0.5 m at sea
Total						**68**	**46**		**35.5**	

RSN Low Voltage Node Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Est Labor (20k/mo)	Total	Quote List	Detail
Seafloor Frame	1	$ 20,000	$ 20,000	$ 20,000	$ 40,000		Seafloor Frame - Made out of steel to hold pressure housing and ROV Connectors - Includes cost of syntactic foam.
Pressure Housing + Endplate Fab	1	$ 36,000	$ 36,000	$ 10,000	$ 46,000	4120-00012	14.8" Internal Diameter Copper Beryllium Pressure housing with endplate fabricated for Connectors
Internal Chassis	1	$ 10,000	$ 10,000	$ 10,000	$ 20,000		Internal Mounting frame for all electronics. Includes meathod for head transport and distribution to external pressure housing.
Ethernet Switch	1	$ 3,000	$ 3,000		$ 3,000	4120-00006	Industrial 1Gige Switch with 2 SFP Modules populated for 10km Optical Transport
DC-DC Conv	5	$ 2,000	$ 10,000		$ 10,000	4120-00009	400 Volt to 48 Volt Regulated Power Supplies for science Ports and internal use. Includes Mounting PCB, Heat Distribution, Issolation Electronics and Filtering,
PPS Timing And Control	1	$ 5,000	$ 5,000		$ 5,000		This includes the Pulse Per Second and Control signal Descoding/Distribution and the required E/O Transcievers
Node Controller	1	$ 5,000	$ 5,000		$ 5,000	4120-00008	Industrial PC104 Controller Stack including the Controller and all A/D and D/A functionality needed to control the power systems and monitor the environmental status of the system. It also includes the cost of the environmental sensors
External 400V Monitor + Distribution	1	$ 2,000	$ 2,000		$ 2,000	4120-00010	Subsystem to condition and monitor the input 400 volt conection and condition/monitor and switch the two 400 Volt output connections
Internal Wiring	1	$ 10,000	$ 10,000		$ 10,000		All internal wire harness for subsystems and connectors.
Unit Assembly	1			$ 20,000	$ 20,000		
					$ -		
					$ -		
Total			$ 101,000	$ 60,000	**$ 161,000**		

	Name	Signature Field
Doc Num	**4140-00016**	
Estimated By		
Revision	**2-01**	
Date	**10/31/2008**	
Approved By		
Date		

Notes: This estimate does not include any external connectors and they will be added later for each specific configuration.

RSN Material List Basis of Estimate Sheet - Cable

Item	Est Cost/Meter	Quote List	Detail
High Power Seafloor	$ 25	4120-00003	
High Power Riser	$ 55	4120-00003	
Armour High Power Seafloor	$ 40	4140-00024	
Low Power Sensor	$ 10		
Total			

Doc Num	**4140-00018**	Notes:
Estimated By		
Revision	**Ver_2-01**	
Date	**10/31/2008**	
Approved By		
Date		

RSN Material List Basis of Estimate Sheet - Connectors

Item	Est Cost/Meter	Quote List	Detail
ROV Electrical	$ 10,000	4120-00001	
ROV Hybrid	$ 35,000	4120-00001	
ROV Optical	$ 20,000	4120-00001	
Dry Electrical	$ 500	4120-00004	
Dry Hybrid	$ 1,000		
Total			

Doc Num	**4140-00019**	Notes:
Estimated By		
Revision	**Ver_2-01**	
Date	**10/31/2008**	
Approved By		
Date		

RSN Material List Basis of Estimate Sheet - CableTerminationAssembly

Item	Est Cost/Meter	Quote List	Detail
Electrical	$ 5,000	4140-00002	
Optical	$ 10,000	4140-00002	
Strong O	$ 25,000		
Strong E	$ 20,000		
Total			

			Notes:
	Estimated By		
	Revision	**Ver_2-01**	
	Date	**10/31/2008**	
	Approved By		
	Date		

RSN HD Interface Box Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Est Labor (20k/mo)	Total	Quote List	Detail
Seafloor Frame	1	$ 10,000	$ 10,000		$ 10,000		Seafloor Frame - Made out of steel to hold pressure housing and ROV Connectors - Includes cost of syntactic foam.
Pressure Housing + Endplate Fab	1	$ 16,000	$ 16,000		$ 16,000	4120-00012	8" Internal Diameter Copper Beryllium Pressure housing with endplate fabricated for Connectors
Internal Chassis	1	$ 1,000	$ 1,000		$ 1,000		Internal Mounting frame for all electronics. Includes meathod for head transport and distribution to external pressure housing.
Ethernet Switch	1	$ 2,000	$ 2,000		$ 2,000	4120-00006	Industrial 100Mbyte Switch
DC-DC Conv	2	$ 500	$ 1,000		$ 1,000	4120-00009	48 Volt Regulated Power Supplies for science Ports and internal use. Includes Mounting PCB, Heat Distribution, Issolation Electronics and Filtering,
Node Controller	1	$ 5,000	$ 5,000		$ 5,000	4120-00008	Industrial PC104 Controller Stack including the Controller and all A/D and D/A functionality needed to control the power systems and monitor the environmental status of the system. It also includes the cost of the environmental sensors
Internal Wiring	1	$ 2,000	$ 2,000		$ 2,000		All internal wire harness for subsystems and connectors.
Unit Assembly	1			$ 15,000	$ 15,000		
					$ -		
					$ -		
Total			$ 37,000	$ 15,000	**$ 52,000**		

		Signature Field
Doc Num	**4040-00021**	
Estimated By	**Harrington**	
Revision	**2-01**	
Date	**10/31/2008**	
Approved By		
Date		

Notes: This estimate does not include any external connectors and they will be added later for each specific configuration.

RSN Material List Basis of Estimate Sheet - Instrument

Sensor ID	Discription	Estimate	Quote List	Detail
OPTAA	attenuation_absorption_optical	$ 5,800	4120-00056	mfr quote
CAMDS	camera_digital_still_strobe	$ 55,000	4120-00033	mfr quote
CAMHD	camera_digital_video_HD	$ 96,000	4120-00043	mfr quote
CTDPF	CTD_profiler	$ 10,060	4120-00034	mfr quote
PPSDN	DNA_particulate	$ 45,000	4120-00031	mfr quote + alterations +PI quote
OTISF	flow_benthic	$ 100,000	4120-00058	PI quote
FLORT	Fluorometer_three_wavelength	$ 13,905	4120-00049	mfr quote
FLORD	Fluorometer_two_wavelength	$ 4,600	4120-00048	mfr quote
HYDBB	Hydrophone_BB_passive	$ 10,092	4120-00032	mfr quote
HPIES	IES_pressure_velocity	$ 50,000	4120-00050	PI quote
MASSP	mass_spectrometer	$ 65,000	4120-00055	mfr quote
ACOMM	Modem_acoustic	$ 9,188	4120-00054	mfr quote
NUTNR	nutrient_Nitrate	$ 30,990	4120-00039	mfr quote
DOSTA	oxygen_dissolved_stable	$ 1,326	4120-00035	mfr quote
PARAD	PAR	$ 1,125	4120-00037	mfr quote
PCO2W	pCO2_water	$ 19,000	4120-00051	mfr quote
PHSEN	pH	$ 3,995	4120-00036	mfr quote
BOTPT	pressure_bottom_tilt	$ 80,000	4120-00041	mfr quote + alterations
PREST	pressure_SF_tidal	$ 35,000	4120-00042	mfr quote + alterations
OBSBB	Seismometer_BB_triaxial_accel	$ 100,000	4120-00047	PI quote
OBSBK	Seismometer_BB_triaxial_keck	$ 40,000	4120-00047	PI quote + alterations
OBSSP	Seismometer_shortperiod	$ 30,000	4120-00044	PI quote + alterations
OBSSK	Seismometer_shortperiod_keck	$ 5,000	4120-00044	PI quote + alterations
SPKIR	spectral_irradiance	$ 8,455	4120-00038	mfr quote
THSPH	Temp_H2_H2S_pH	$ 20,000	4120-00059	PI quote
TRHPH	Temp_resist	$ 45,000	4120-00061	PI quote
TMPSF	Temperature_seafloor	$ 30,000	4120-00060	PI quote
VEL3D	Velocity_point_3D_turb	$ 14,000	4120-00053	mfr quote
ADCPT	Velocity_profile_300m	$ 38,926	4120-00040	mfr quote
VADCP	Velocity_profile_50m_turb	$ 65,000	4120-00052	mfr quote
ADCPS	Velocity_profile_600m	$ 47,405	4120-00040	mfr quote
OSMOI	watersample_chem_trace	$ 15,000	4120-00057	mfr quote
RASFL	watersample_chem_trace_H2S_pH	$ 70,000	4120-00030	mfr quote + alterations+PI quote

		Notes:
Doc Num	**4140-00022**	
Estimated By		
Revision	**Ver_2-02**	
Date	**10/31/2008**	
Approved By		
Date		

RSN Vertical Mooring Spares Basis of Estimate Sheet

Item	**Qty**	**Est Cost**	**Ext**	**Modules**	**Quote List**	**Detail**
EOM Cable						
ROV Hybrid Connectors	2	$ 35,000	$ 70,000		4120-0001	
Mooring Cable	3.2(km)	$ 55,000	$ 176,000		4120-0003	
Mooring Cable Termination	2	$ 10,000	$ 20,000	$ 266,000	4120-0002	
Seafloor Cable						
ROV Hybrid Connectors	2	$ 35,000	$ 70,000	$ 70,000	4120-0001	
Anchor System						
Anchor	2	$ 16,000	$ 32,000			
Releases	4	$ 20,000	$ 80,000	$ 112,000		
200 M Platform						
Structural Titanium	1	$ 25,000	$ 25,000			
Sytactic Foam	1	$ 60,000	$ 60,000	$ 85,000		
Misc						
EOM Cable Floats	50	$ 1,000	$ 50,000			
Structural Ti for Aux Frame	1	$ 20,000	$ 20,000			
Misc Material	1	$ 33,000	$ 33,000	$ 103,000		
Sub Totals			$ 636,000	$ 636,000		
Total Mooring System						

	Name
Doc Num	**4140-00023**
Estimated By	**Cram**
Revision	**1-00**
Date	**2/1/2011**
Approved By	
Date	

Notes: See 4140-00011 and 4140-00012 for Aloha Mooring Replication Cost Information

RSN Sensor Interface Box Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Est Labor (20k/mo)	Total	Quote List	Detail
Seafloor Frame	1	$ 2,000	$ 2,000		$ 2,000		Seafloor Frame - Made out of steel to hold pressure housing and ROV Connectors - Includes cost of anchor
Housing	1	$ 7,000	$ 7,000		$ 7,000		Oil Filled Pressure Balanced Housing for connector wiring distribution
Internal Wiring	1	$ 1,000	$ 1,000		$ 1,000		All internal wire harness for subsystems and connectors.
Unit Assembly	1			$ 10,000	$ 10,000		
					$ -		
					$ -		
Total			$ 10,000	$ 10,000	**$ 20,000**		

	Name	Signature Field
Doc Num	4140-00025	
Estimated By	Harrington	
Revision	2-00	
Date	10/1/2008	
Approved By		
Date		

Notes: This estimate does not include any external connectors and they will be added later for each specific configuration.

RSN Medium Power Junction Box Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Est Labor (20k/mo)	Total	Quote List	Detail
Seafloor Frame	1	$ 20,000	$ 20,000	$ 10,000	$ 30,000		Seafloor Frame - Made out of steel to hold pressure housing and ROV Connectors - Includes cost of syntactic foam.
Pressure Housing + Endplate Fab	1	$ 36,000	$ 36,000	$ 10,000	$ 46,000	4120-00012	14.8" Internal Diameter Copper Beryllium Pressure housing with endplate fabricated for Connectors
Internal Chassis	1	$ 10,000	$ 10,000	$ 10,000	$ 20,000		Internal Mounting frame for all electronics. Includes method for head transport and distribution to external pressure housing.
Ethernet Switch	1	$ 3,000	$ 3,000		$ 3,000	4120-00006	Industrial 1Gige Switch with 2 SFP Modules populated for 10km Optical Transport
DC-DC Conv	9	$ 500	$ 4,500		$ 4,500	4120-00009	48 Volt To Sensor Specific Regulated Power Supplies for science Ports and internal use. Includes Mounting PCB, Heat Distribution, Issolation Electronics and Filtering,
PPS Timing And Control	1	$ 4,000	$ 4,000		$ 4,000		This includes the Pulse Per Second and Control signal Descoding/Distribution and the required E/O Transcievers
Node Controller	1	$ 5,000	$ 5,000		$ 5,000	4120-00008	Industrial PC104 Controller Stack including the Controller and all A/D and D/A functionality needed to control the power systems and monitor the environmental status of the system. It also includes the cost of the environmental sensors
Serial to Ethernet Converter	8	$ 100	$ 800		$ 800	4120-00007	Serial to Etherenet converters on each sensor input. Can be configured for RS485 or RS232 Includes Isolation Circuit
External 400V Monitor + Distribution	1	$ 1,000	$ 1,000		$ 1,000	4120-00010	Subsystem to condition and monitor the input 400 volt conection and condition/monitor and switch the two 400 Volt output connections
Internal Wiring	1	$ 2,000	$ 2,000		$ 2,000		All internal wire harness for subsystems and connectors.
Unit Assembly	1			$ 30,000	$ 30,000		
					$ -		
					$ -		
Total			$ 86,300	$ 60,000	**$ 146,300**		

	Name	Signature Field
Doc Num	**4140-00013**	
Estimated By		
Revision	**2-02**	
Date	**10/31/2008**	
Approved By		
Date		

Notes: This estimate does not include any external connectors and they will be added later for each specific configuration.

RSN Low Power Junction Box Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Est Labor (20k/mo)	Total	Quote List	Detail
Seafloor Frame	1	$ 10,000	$ 10,000	$ 10,000	$ 20,000		Seafloor Frame - Made out of steel to hold pressure housing and ROV Connectors - Includes cost of syntactic foam.
Pressure Housing + Endplate Fab	1	$ 16,000	$ 16,000		$ 16,000	4120-00012	8" Internal Diameter Copper Beryllium Pressure housing with endplate fabricated for Connectors
Internal Chassis	1	$ 3,000	$ 3,000		$ 3,000		Internal Mounting frame for all electronics. Includes meathod for head transport and distribution to external pressure housing.
Ethernet Switch	1	$ 2,000	$ 2,000		$ 2,000	4120-00006	Industrial 100Mbyte Switch
DC-DC Conv	9	$ 500	$ 4,500		$ 4,500	4120-00009	48 Volt Regulated Power Supplies for science Ports and internal use. Includes Mounting PCB, Heat Distribution, Issolation Electronics and Filtering,
PPS Timing And Control	1	$ 3,000	$ 3,000		$ 3,000		This includes the Pulse Per Second and Control signal Descoding/Distribution
Node Controller	1	$ 5,000	$ 5,000		$ 5,000	4120-00008	Industrial PC104 Controller Stack including the Controller and all A/D and D/A functionality needed to control the power systems and monitor the environmental status of the system. It also includes the cost of the environmental sensors
Serial to Ethernet Converter	8	$ 100	$ 800		$ 800	4120-00007	Serial to Etherenet converters on each sensor input. Can be configured for RS485 or RS232 Includes Isolation Circuit
Internal Wiring	1	$ 2,000	$ 2,000		$ 2,000		All internal wire harness for subsystems and connectors.
Unit Assembly	1			$ 20,000	$ 20,000		
					$ -		
					$ -		
Total			$ 46,300	$ 30,000	**$ 76,300**		

	Name	Signature Field
Doc Num	**4140-00014**	
Estimated By	**Harrington**	
Revision	**2-02**	
Date	**10/2/2008**	
Approved By		
Date		

Notes: This estimate does not include any external connectors and they will be added later for each specific configuration.

Regional Scale Nodes

BOE Cover Sheet

RSN Quote Number	**4140-00011**
For:	
Type:	NSF Report
Date:	
Company:	
Requested By:	

Notes: This extract of a report to NSF describes the Aloha Mooring system with replication costs.

Status Report
SENSORS: Collaborative Research:
ALOHA Mooring Sensor Network and Adaptive Sampling

NSF Grant OCE 0330082

PI: Bruce M. Howe
Applied Physics Laboratory, University of Washington, Seattle, WA, USA

24 June 2007

Summary

The primary objective of the project is to demonstrate a prototype cabled mooring sensor system with profiling capability, an essential element of NSF's ORION program and the associated Ocean Observatories Initiative (OOI). The seafloor portion of the system is installed and working at a shallow water test site in Puget Sound (including the 1700 m electro-optical seafloor cable, electrical-optical media converters, seafloor secondary node, and instrument package with CTD, oxygen and optical backscatter/fluorometer). The mooring is assembled and working in the Lab, with test deployment scheduled in late June 2007. Testing will continue through the summer before deployment on the MARS Observatory in spring 2008 for six months. A variety of factors (e.g., technical challenges and scheduling delays) have raised the cost and duration of the project. Present funds will be expended in July 2007; discussions with NSF are in progress to secure additional funds.

Introduction

The original goal of the project was to deploy a first-of-its-kind cabled mooring sensor network, including a profiler with inductive battery charging, on the ALOHA Cabled Observatory (ACO) at the HOT site north of Oahu. This sensor network would enable scientific adaptive sampling within the framework of the (now) 19-year HOT time series. The project started October 2003 and was planned to run three years. Two significant delays of one year each occurred. First, the viability of the ACO was in doubt (on technical and funding grounds), ultimately leading us to decide to deploy the mooring on the MARS Observatory in Monterey Bay. Next, reduced UNOLS funding postponed the deployment cruise from 2006 to 2007. Most recently, the MARS node installation has been delayed, with commissioning now likely in January 2008. While these factors have allowed additional time to solve technical problems and to develop a more robust system—they have resulted in increased cost. The primary reason for the increase is underestimating the technical challenges and effort with the associated costs.

The testing of the mooring system is now under way in Puget Sound. The seafloor cable, node, and instrument package are working in place. In the very near future a short version of the mooring system will be deployed and tested in a water depth that can be serviced by SCUBA divers (30 m). Existing funding will expire at that point. The subsequent work will require the new funding. When the shallow tests are complete and the equipment serviced, the system will be deployed in Monterey on the MARS observatory in winter/spring 2008 and recovered in late summer 2008. A successor mooring will be proposed for the ACO after a cabled node is finally installed in November 2007 at that site. Additional moorings of this type will play a significant role in the NSF funded ORION program and its Ocean Observatories Initiative (OOI).

The role of co-PI Lukas at the University of Hawaii is to manage and analyze data, and to develop adaptive sampling; this remains unchanged. His original funding is largely intact; when the mooring system is in the water and operating in Puget Sound, he will start to contribute in these areas in a major way. The role of co-PI Boss at the University of Maine was in bio-optical sensor selection and advising and is now complete, though maintaining involvement.

In this document, we first provide a current as-built description of the mooring system. The following section describes the work yet to be completed, the specific tasks, and levels of effort. Risk mitigation, synergies with other projects and financial status are described next. This report is meant to serve as a detailed supporting document for the shorter, separate request to NSF for supplemental funding.

The ALOHA-MARS Mooring (AMM) project will demonstrate the scientific potential of combining adaptive sampling methods with a moored deep-ocean sensor network. It is designed for use with seafloor observatories with power and communications provided by a connection to shore via an electro-optical cable. This system will address the challenge of sampling the ocean with both high temporal and vertical resolution. The scientific justification for the project is not reviewed here. Pertinent references, as well as ones concerning the present engineering effort are given in the list of references at the end. This includes the project web page, conference publications and presentations, the original proposal, engineering documents, a wiki for software, the Seahurst Observatory, and ORION documents (science plan, Concept Network Design, and the Daly et al. RFA concept proposal that describes science using moorings of this type).

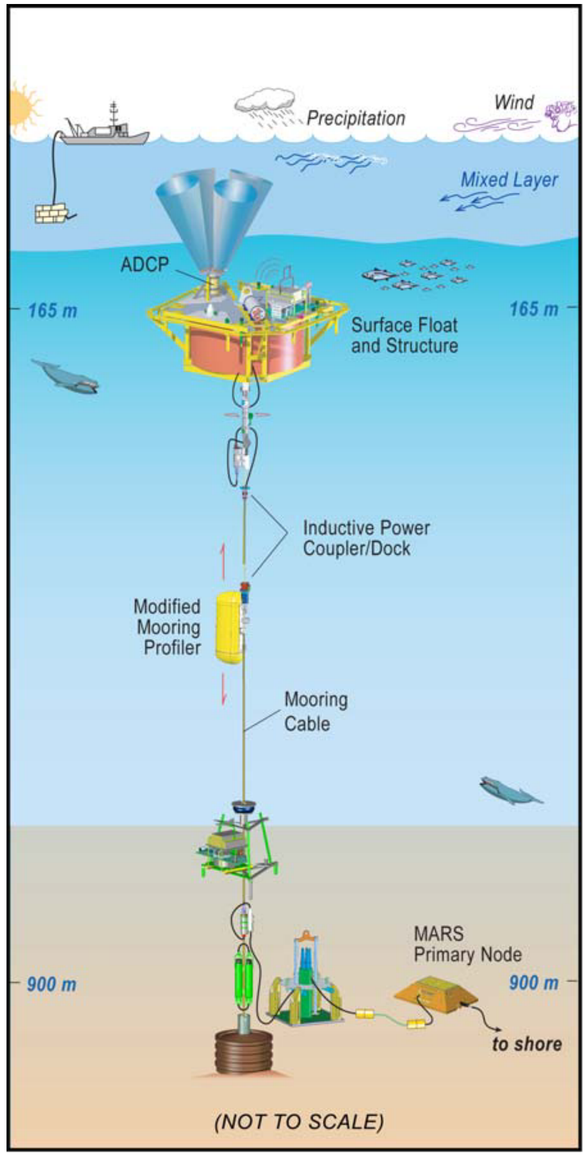


Figure 1. ALOHA-MARS Mooring (AMM) system

Mooring system

The mooring system consists of three main components (Figures 1 and 2): a near-surface float at a depth of 165 m with a secondary node and suite of sensors, an instrumented motorized moored profiler moving between the seafloor and the float that will mate with a docking station just beneath the float for battery charging, and a secondary node on the seafloor with a suite of sensors. Both secondary nodes have ROV-mateable connectors available for guest instrumentation. The profiler has real-time communications with the network via an inductive modem that provides some remote control functions to allow the sampling and measurement capabilities to be focused on the scientific features of greatest interest. The power and two-way real-time communications provided by cabled seafloor observatories will enable this sensor network, the adaptive sampling techniques, and the resulting enhanced science. The sampling and observational methods developed here will be transferable to ocean observatories elsewhere in the world.

The entire system has been tested in the laboratory; parts of it have been tested in shallow water. We are now installing the mooring for tests at the Seahurst Observatory. The system description given here reflects all the work accomplished to date. The following sections provide more detail on the individual components.

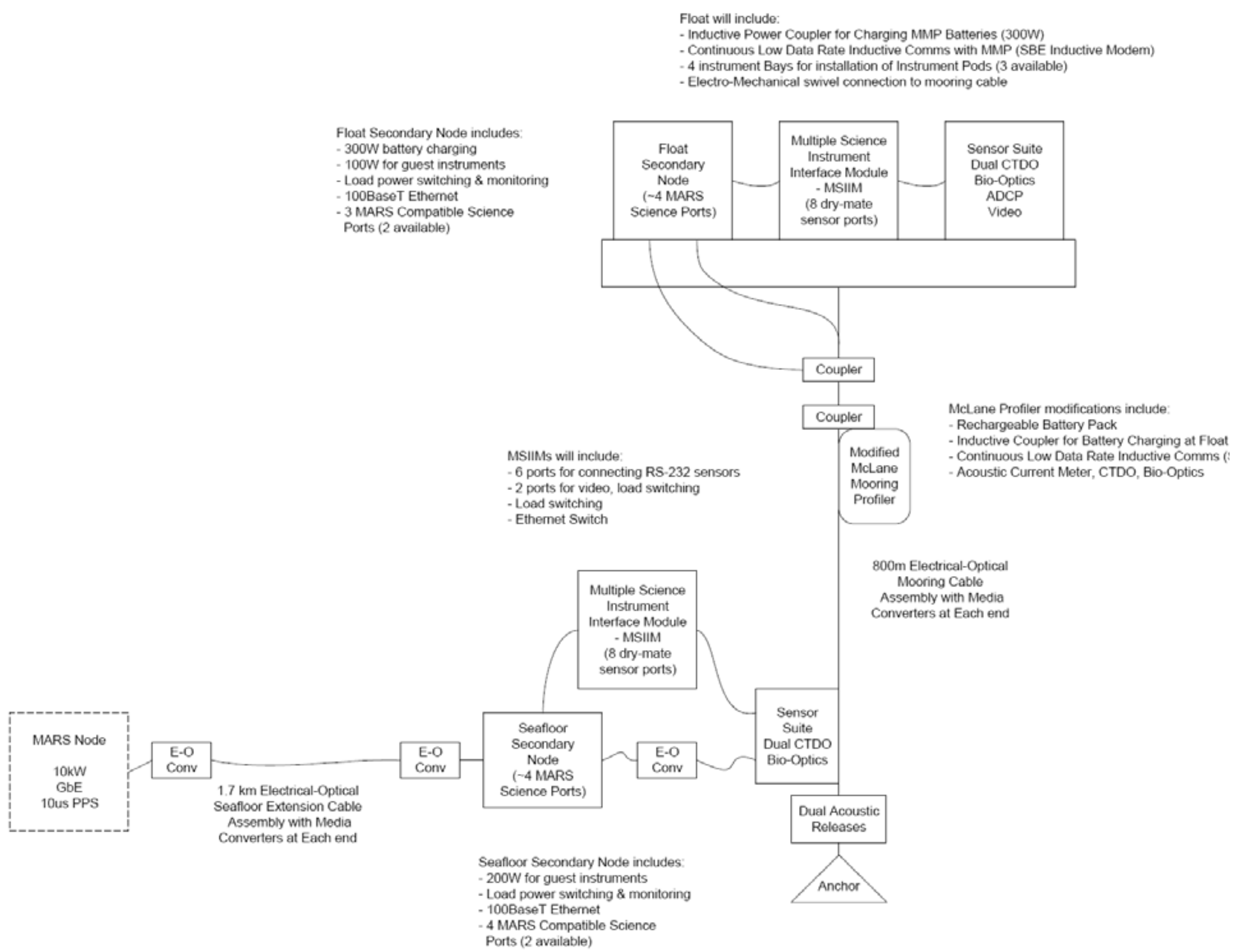


Figure 2. AMM system diagram

Seafloor cable and EO-converters

ROV-mateable connectors on the MARS Observatory primary node will provide 375 V, 48 V, 100Base-T Ethernet, and a 1 pulse-per-second (PPS) precise timing signal. The mooring system is designed for a maximum of 1200 W with 320 W for the profiler charging and 270 W for guest users. In-line electro-optical media converters (Figure 3) are required to convert electrical communication and timing signals to optical form for transmission over any significant distance using optical fibers and back again. The seafloor and mooring riser cables both have four single mode fibers. One optical fiber is used for the Ethernet communications, and one for the PPS/RS-422 time distribution and two are spares. Wave division multiplexers (WDMs) allow bi-directional data transmission using 1310 and 1550 nm wavelengths on the fibers. The 1.7-km cable between the primary node and the seafloor secondary node junction box is a 12.7-mm diameter electrical/optical cable with six electrical conductors and the optical fibers in a 1.2-mm stainless steel tube. ROV-mateable connectors allow connection of the cable to the primary and secondary nodes. The seafloor cable (with EO converters and connectors) will be installed by ROV with a reel that will be mounted in the cable laying tool sled on the ROV; the spool will be left on the seafloor at the end of the cable laying process.

Figure 3. EO converters with ROV-mateable connectors on the green cables and the black seafloor cable between

These, and all mooring system components, have a depth rating of 5000 m.

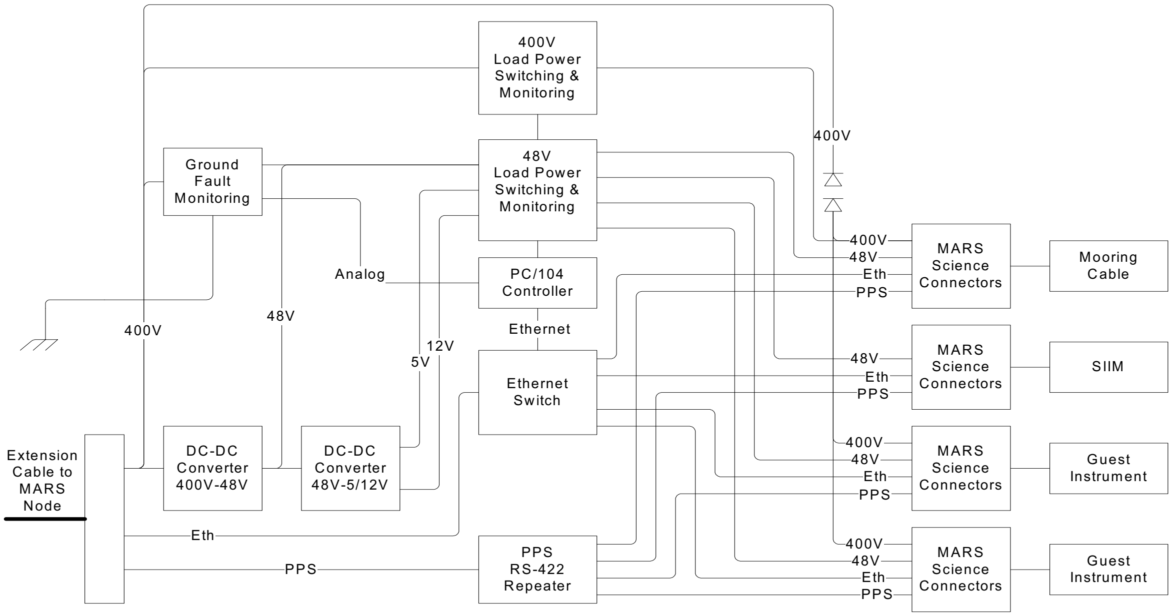


Figure 4. Secondary node block diagram (375 V rather than 400 V is now supplied by MARS)

Secondary nodes

The AMM has two secondary nodes that provide the same connectivity functions that are available at the primary observatory nodes, though power and communications clearly are now shared resources. Figure 4 shows the basic block diagram for the secondary nodes; there are small differences between the seafloor and float secondary nodes that will be discussed in the following sections. Much of the design is based on the MARS power system (e.g., bus structure, PC-104 node controller, switching and monitoring of ports, and ground fault monitoring).

The seafloor secondary node serves as the terminus for the seafloor EOM cable that runs from the MARS node to the base of the mooring. The node includes a frame, electronics housing, and ROV-mateable electrical connector receptacles. The mechanical design of the node was done in consultation with the ROV pilots at MBARI. There are two guest ports in addition to ports for the seafloor cable from the primary nodes, the mooring cable (to the float node), and the instrument package. Figure 5 shows the seafloor node on the deck of the APL-UW workboat R/V *Miller* during the Seahurst work (without the buoyancy that will be used for the MARS deployment to facilitate ROV handling).

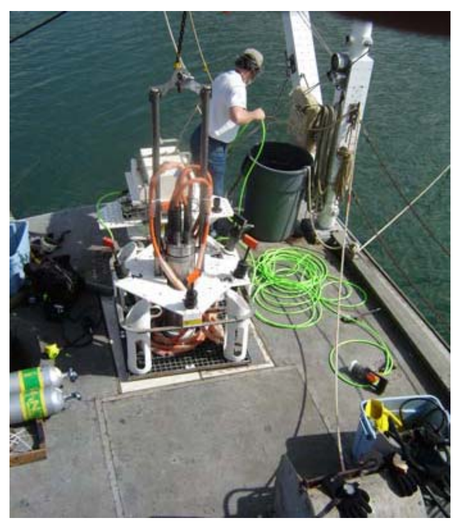


Figure 5. Seafloor secondary node and instrument package ready for deployment at Seahurst Observatory

The subsurface float secondary node is connected via the mooring cable to the seafloor node next to the base of the mooring anchor. It is also connected to the AMM float instrument package and has two unused guest ports with ROV-mateable receptacles. In addition it has the electronics for the inductive power coupler, the Sea-Bird inductive modem for communication with the profiler, an internal attitude sensor, the acoustic Doppler current profiler (ADCP), and video camera and light (looking at the profiler docking station below the float).

Science Instrument Interface Module (SIIM)

To minimize the number of ROV-wet-mateable connectors used, an intermediate multiplexer/SIIM is used to first connect all the sensors at one location together (using inexpensive dry-mate connectors); then the SIIM is connected to the secondary node housing using a single (expensive \$15k – \$20k mated pair) ROV-mateable connector (Figure 6). This SIIM has a mix of the following features: eight ports (dry-mate connectors), power at required instrument voltages (48 Vdc or 12 Vdc); Ethernet or RS-232 to Ethernet conversion (to connect to network), and individual software controlled load switching and deadface switching. Much of this is accomplished with a custom, easily modified, four-channel printed circuit board, a "SIIM board" (top of Figure 6). Each channel has a DigiConnectME embedded module, a FET switch, and deadface relays. The DigiConnect module provides a 10/100BaseT network interface (i.e., an IP address), one high-speed RS-232 serial interface, 2 MB Flash memory, and 8 MB RAM. It provides an extremely convenient way to convert instrument RS-232 to Ethernet. It is the only "smart" device in the SIIM. On the float and at the base of the mooring, the SIIM board is housed in a titanium pressure case rated for 5000 m. A SIIM board also resides in the float secondary node for the attitude sensor, ADCP, and Sea-Bird inductive modem. Both SIIMs provide PPS time distribution to one port that will be used for the acoustic modem for synchronization of communications and navigation.

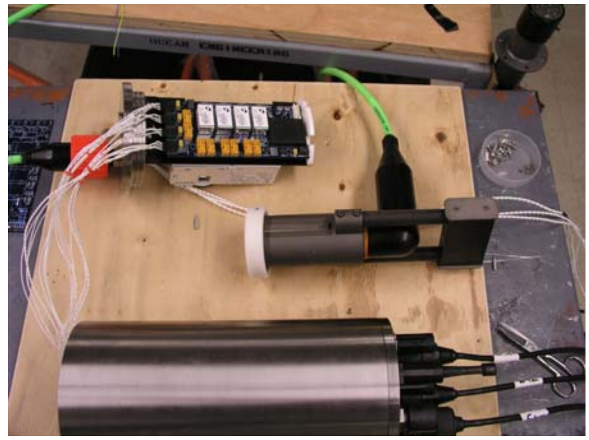


Figure 6. SIIM pressure case, electronics, and connector

Sensors and instruments

The Sea-Bird 52MP/43F pumped $CTDO_2$ is used throughout, two each (for redundancy) on the subsurface float and at the base of the mooring (Figures 7 and 8), and one on the profiler. These have titanium pressure cases rated for 6000 m. The WetLabs BBF2 sensor measures optical backscatter at 470 nm and 700 nm, and chlorophyll fluorescence within the same volume. There is one each on the float and seafloor instrument packages and on the MMP. The ADCP on the subsurface float is a RD Instruments Workhorse Quartermaster 150 kHz. It is mounted permanently on the float with a dry mate connector to the float secondary node electronics case. The ADCP has an integral attitude sensor package. The ACM on the profiler is a Falmouth Scientific 4-axis device measuring a 3D velocity vector. There will be a broadband hydrophone (Naxys eHyd, expected June 2007, funded largely by APL-UW) on the subsurface float and acoustic modems on the two instrument packages, supplied by Woods Hole Oceanographic Institution (funded by a NASA Sensor Web grant).

Figure 7. The seafloor instrument package on a section of mooring cable on its frame

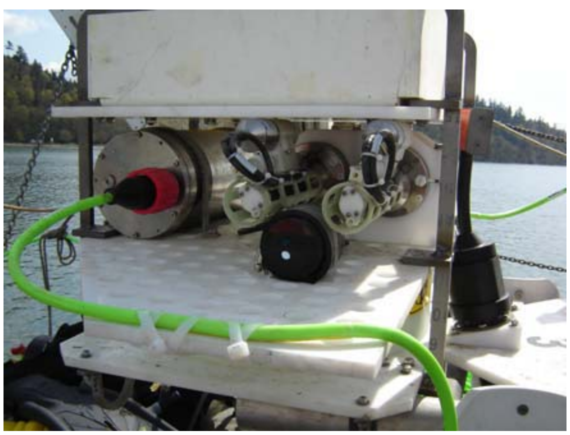


Figure 8. The seafloor instrument package with SIIM pressure case and the BB2F and dual $CTDO_2$

A gyro enhanced orientation sensor in the float secondary node will be used to better understand the float/mooring dynamics, related stresses, and impact on the optical fibers; it will help answer the question, is a swivel necessary in future mooring systems like this? There is a color video camera with lights mounted below the subsurface float looking at the profiler dock to monitor the MMP docking and undocking.

Moored profiler

The project has modified the McLane Moored Profiler (MMP, Figure 9). The changes include: new motor, gearbox, and wheel for use with the larger EOM cable; interface for Wet Labs and Seabird sensors; interface APL-UW moored profiler controller (MPC) to the MMP controller to offload data after every profile; replace primary Li battery pack with rechargeable 860 Wh Li-ion battery bank mounted in glass sphere; mount for inductive charging coupler and electronics; and use extended length McLane housing with additional glass sphere for rechargeable battery bank and for increased buoyancy. With these changes, there will be a data collecting-to-battery charging duty cycle of 95% (4 days operation with 4 h charging). The MPC (a CF-2 processor) collects the BB2F optical data (backscatter and fluorescence), interfaces with and downloads data from the MMP ($CTDO_2$, ACM, engineering data), interfaces with and transfers data/commands to/from the shore server (SS), and supervises the charging of the battery bank.

Figure 9. The modified moored profiler being tested on the APL-UW R/V *Henderson* with inductive power coupler

Inductive Power System (IPS)

The inductive power transfer to the profiler is one of the new technical developments of the project. The MMP periodically connects or "docks" to the mooring float infrastructure to charge its battery bank. S&K Engineering has designed and fabricated the inductive power coupler (the "dock", two mating halves of a transformer, conceptually like a cordless electric toothbrush charger) and the associated drive and charging electronics; the coupler is shown in Figure 10. It can deliver 200 W using a 50-kHz switching frequency with 70% efficiency.

Figure 10. Inductive power coupler

Inductive Modem (IM) communications

The SeaBird Inductive Modem (IM) system is used for communications between the float and the MMP. The float contains the IM node that is connected to shore through the mooring network and the MMP contains another IM node that connects to the MPC, allowing bi-directional communications. Communications rate is nominally 150 bytes/s; with forward error correction and other overhead the effective rate is 90 bytes/s.

Mooring riser cable

The 22-mm (0.85-inch) diameter mooring cable has six 18 AWG conductors with polypropylene insulation, four loose fibers in a 1.3-mm diameter steel tube (in center), a Kevlar strength member, and a steel mesh for fish bite protection, all enclosed in a polyurethane jacket. This cable, connecting the seafloor secondary node to the subsurface float and the float secondary node, has electrical connector terminations and EO converters identical to the seafloor cable connecting the MARS primary node to the seafloor secondary node. Initial pull tests of the cable with the mechanical terminations failed; the terminations were improved and the tests were completed successfully.

Mooring float

The subsurface float tensions the mooring riser cable and serves as an instrument platform. Figure 11 shows the float and structure with the float instrument package and ADCP. The 300-m depth rated syntactic foam float is 1.8 m diameter, 0.8 m high, weighs 2052 lbs in air, and has a buoyancy of 2375 lbs. The float structure is made from 6061-T6 painted aluminum. An electro-mechanical swivel/slip ring assembly is used at the top end of the mooring cable just beneath the subsurface float. The swivel has 16 slip rings in an oil-filled, pressure-compensated housing with an external pressure compensator (Figure 12). The stainless steel swivel is rated at three metric tonnes (6600 lbs) working load.

Figure 11. Subsurface float and frame with secondary node in background, ADCP, and instrument package in foreground with ROV-mateable connector

Figure 12. Pressure balanced, oil-filled electrical-mechanical swivel with external pressure compensator/oil reservoir

Software

The successful operation of the mooring sensor network depends on software. The mooring system uses a scaled-down version of the MARS power monitoring and control system (PMACS) with the secondary node controller (SNC) serving a similar role as the MARS node power controller. The SNC (a PC-104 stack) monitors load current and bus voltage, allows for the setting of per-load current limits, and provides circuit-breaker and ground-fault monitoring capabilities. The PMACS server communicates with the SNC via an XML-RPC interface. The shore server (SS) runs a dedicated process for each sensor (an instrument server process). Each process interfaces to its respective sensor over the network and archives the sensor data on the local disk. All sensor configuration will be handled through the SS (for software and network description see the project wiki page). In total, there are 36 IP addresses required.

The profiler has required a significant amount of software associated with the transfer of data from the MMP controller, communications over the inductive modem, acquisition of data from non-MMP sensors (the BB2F), and the battery charging/docking process. The software and profiler have been operated nearly continuously on the bench since June 2006 for testing/burn-in.

We have postponed effort in the area of data management until we have a working system. The original plan was to construct a simple time-stamped ascii data base for each sensor (this has been implemented); co-PI Lukas at Univ. Hawaii would then read this and import it into the ALOHA HOT live action server (more about this follows).

Testing

Profiler testing – June 2006

In June 2006 the modified moored profiler was tested in shallow water (Figure 9) using the APL-UW R/V *Henderson* at the dock with McLane personnel assisting. The set up was not ideal—fresh water and only 17 ft depth—but the profiler successfully cycled every 8 minutes for 2 days, collecting sensor data (CTD, acoustic current sensor, Wet Labs BB2F optics sensor), transmitting the data in near-real time with the SeaBird inductive modem, transferring the data to an on-shore server using a serial-Ethernet device server, and battery charging with the custom inductive power coupler (~200 W). The sensor data were available on-line and web graphing tools were used for presentation. In this test, the water depth was a limiting factor—the profiler hit the anchor before it ramped up to full speed. The profiler senses that the pressure/depth is not changing and it times out and waits for the next profile.

Seahurst Observatory

The original proposed plan for realistic testing prior to open ocean use was to use the VENUS cabled system in Saanich Inlet near Victoria, British Columbia. This system was significantly delayed; it was only installed in March 2006. This, combined with a realization that it would be more expensive and difficult to access than originally thought, led us to consider installing a test facility closer to home in Puget Sound. A suitable site was found at Seahurst Park in the city of Burien, just west of the Sea-Tac International Airport. The Sea-Tac Occupational Skills Center Marine Technology Program occupies a marine station on the shore of the park; this program offers high school classes and maintains salmon fish tanks in the building. The latter require continuously pumped water, with pipes perfect for housing and protecting a cable out to a water depth of 8 m at a distance of 270 m offshore.

Starting in March 2006, volunteers from APL-UW worked to run a messenger line through one of the pipes, with success in July. In November, a power cable and a fiber-optic communications cable were installed. In late February 2007, a “simple” node and instrument package (Figure 13) were installed at the end of the pipe. The node provides a 48 Vdc and 100 Mb/s Ethernet electrical connection to the instrument package SIIM, which has a simple CTD and video camera; the latter recorded the seal shown in Figure 14 (see references at the end for the web page). The node also provides one port with 375 Vdc and 100 Mb/s Ethernet on a ROV-mateable connector, to which we connect the AMM seafloor cable.

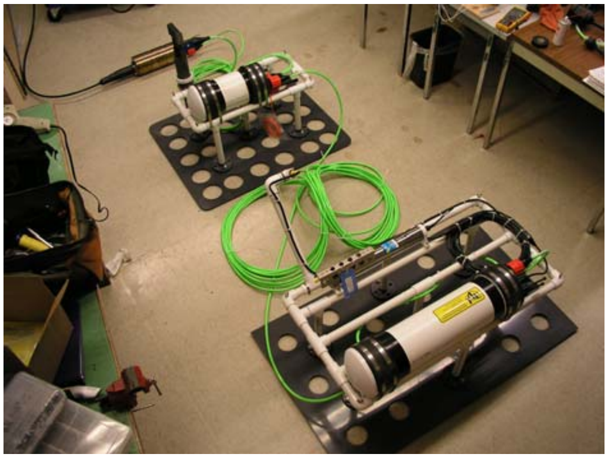


Figure 13. Seahurst node and SIIM with CTD

Figure 14. A picture from the Seahurst node – a harbor seal in the foreground

Seafloor cable, secondary node, and instrument package

On 8 March 2007, the AMM seafloor cable, secondary node and instrument package were installed in 30 m of water from the R/V *Miller* with the aid of divers. The vessel was put in a three-point moor and the cable floated shoreward toward the Seahurst node. When in place it was sunk and connected. The seaward end on the vessel was connected to the secondary node/instrument package and tested with success. The components were disconnected, deployed, and reconnected by the divers. But then the system did not work.

Subsequently on 19 March, the components at the seaward end were recovered; all functioned normally on deck. No explanation for the earlier failure was found. A 70-m cable was installed between the seaward EO converter and the node, so the system could remain connected during deployment. Everything worked, as well as the instrument package. After 6 h of working, the communications beyond the seaward EO converter began to suffer dropouts and then failed altogether.

On 28 March, we returned and found that the strain relief grip on the cable at the seaward EO converter connector had frayed and come off, with the cable at a 90° angle, subjecting the connector to considerable strain. While no water was evident in the connector when brought on deck, the cable failed to carry Ethernet signals. The maximum theoretical length of an electrical Ethernet cable is 100 m; the 70-m cable clearly did work earlier but apparently was marginal. With the original 13-m cable between the EO converter and the secondary node, the system was reinstalled and all worked; see plots of data on the Seahurst web page, and Figure 15.

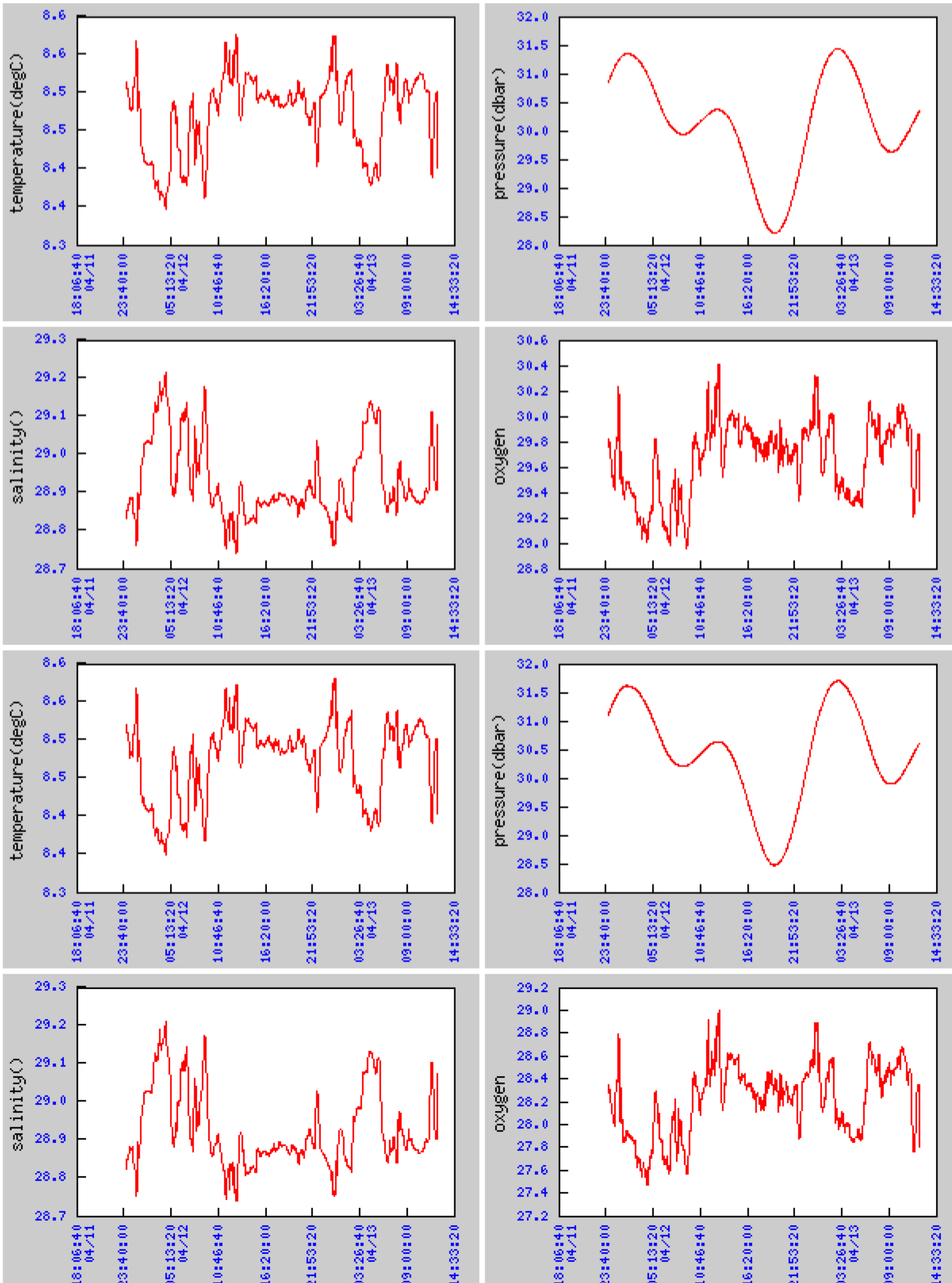


Figure 15. Temperature, salinity, oxygen and pressure from the dual sensors on the seafloor instrument package at 30 m connected to the Seahurst Observatory. Dual sensors will significantly improve the scientific reliability and value of the data.

Deck rail system

The deck rail system that will be used to deploy the subsurface float from the fantail of the R/V *Thompson* (or any of the large UNOLS ships) has been fabricated, assembled and tested, Figure 16. It has subsequently been painted and is ready for use for the deployment.

Figure 16. Deck track and trolley system.

Profiler testing – May - June 2007

On 2 May, the profiler was tested in Puget Sound on a 20 m test mooring cable under 1000 lb tension. The profiler moved up and down the cable and was able to dock, charge, and move out again. There were some communications problems. After making some changes, and while moored in nearby Shilshole marina (deeper water than at the APL dock), the MMP was again tested. This time, though, the wheel continually slipped on the wire and the profiler would not move. After sending the MMP controller back to McLane, there was some improvement (slow intermittent movement), but it was still necessary to add a strip of rubber to increase friction. We have worked with McLane to specify and fabricate a new wheel surface; we have also modified the existing polyurethane wheel surface to increase friction/reduce hydroplaning. The profiler was tested with this modified wheel at Shilshole Bay 22-24 June with success, with over 90 profiles run, including docking and battery charging.

Software

In December 2006, MBARI volunteered to help with "cyberinfrastructure," namely the interface to sensors, the data acquisition, management, and user interface. We have gratefully accepted their offer, tentatively with them handling most of the conventional fixed sensors. They see this project as providing a useful test bed for their SIAM and MOOS software systems, and the Marine Metadata project. They are acquiring data from the seafloor instrument SIIM BB2F optical sensor and one of the two $CTDO_2$ sensors; this will be followed with the float ADCP (presently still in the lab). APL-UW will remain responsible for serving all the data from the profiler as well as the modems, hydrophone, video camera, and engineering sensors. Per the original proposal, Roger Lukas will access the data archives at MBARI and APL-UW to feed into the ALOHA/HOT live-action server. The data will be analyzed, feeding into the development of adaptive sampling methods and techniques.

Work to complete

The mooring system is essentially complete, requiring integrated testing in Puget Sound (Phase 1) and deployment and recovery on the MARS Observatory (Phase 2). Here we describe the tasks and effort for each phase (see also the table below).

Phase 1: Puget Sound

In late June, the 30-m mooring system will be installed at Seahurst. Rather than deploying the large and heavy subsurface float and structure, we will use a 1 m steel sphere float with smaller anchor (~1500 lb) and. Doing this will let us deploy and service from the APL R/V *Miller* with a flexible schedule. The day rate of the *Miller* is $2000/day. To deploy the subsurface float and structure would require the use of a crane barge at more than twice the cost and an inflexible schedule. The float secondary node and the ADCP will be attached to the titanium post, which in turn will connect to the steel sphere float. The expectation is it will remain deployed until September, with intermittent debugging and servicing as required. If a problem occurs, it can be easily recovered and re-deployed. A three-point mooring system set up at the site helps tremendously in work at the site.

If any problems with the profiler arise, the entire profiler can be removed for servicing and debugging. To do this, the inductive power coupler would be disconnected from the profiler.

Supplemental funding will be required to continue beyond this point.

Phase 2: MARS

This phase includes preparation, seafloor cable installation, mooring deployment, and recovery.

Preparation will include cleaning all equipment after the Seahurst operations, calibration of sensors, any necessary modifications and further component testing, and acquisition of spares as necessary.

The seafloor cable will be transferred to a MBARI ROV cable reel. The seafloor system (cable, secondary node, and instrument package) will be tested at MBARI connected to their MARS node simulator. This test will familiarize the ROV pilots with the gear (recall, they were intimately involved in the design), functionality, setting of IP addresses at MBARI, data acquisition and archiving, etc. The seafloor system will be deployed either in November or January using a MBARI ROV with cable laying sled to be sure all is working before the mooring is installed. It is important to get the seafloor portion of the system installed on MARS as soon as possible after MARS primary node installation so there is time to take any corrective action if necessary. The installation of the MARS system has slipped, affecting this project's schedule. We originally planned to install the mooring in November 2007, but now MBARI advises a prudent time would be March 2008 or later. However, it should be noted that the MARS node will be installed in two steps. In the first, an electronics node package that uses a prototype medium voltage (MV) converter (10 kV to 375 V dc) supplied by Alcatel will be installed as a test. We would install the seafloor cable, node, and instrument package after this so as to have the maximum amount of lead time to fix any problems that might arise. Then, in the second step, the node electronics package will be removed, the MV converter replaced with a production unit, and then replaced. After testing, the system will be formally commissioned, ready for use in January 2008. If we do not deploy the seafloor portion of the system in November, late January would be the second choice.

We assume the use of the R/V *Thompson*. Dynamic positioning, a high A-frame (26.5 ft), and a deck long enough for the winch and track system is required (40 ft). The schedule for the deployment and recovery cruises will be determined in the next few months.

Deployment includes mobilization, the cruise itself, and demobilization. Mobilization includes winch preparation and testing (we will be borrowing a winch with a split bay drum from SIO), mounting of float deployment deck trolley/rail system, loading all equipment on the ship, testing equipment, practicing various aspects of the deployment (and recovery), and verifying real time precise GPS navigation and dynamic positioning. For now we assume the cruise will be from Seattle to San Diego via Monterey. The MBARI vessels R/V *Western Flyer* with ROV *Tiberon* and R/V *Lobos* with ROV *Ventana* will be used, which ROVs used when is yet to be determined. Cruise participants will include Howe, McGinnis, Siani, Wen, and Boget; Kenney and Miller will be on shore.

A detailed mooring deployment plan showing every step of the process with realistic solid works model figures is on the project web page (Docs_Under_Config_Control). Figures 17-20 are representative of the various steps.

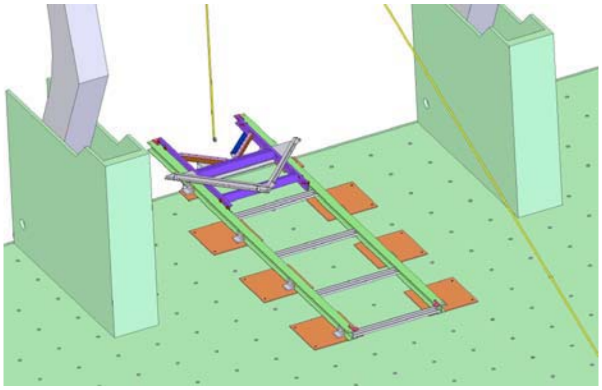


Figure 17. Trolley and track on fantail

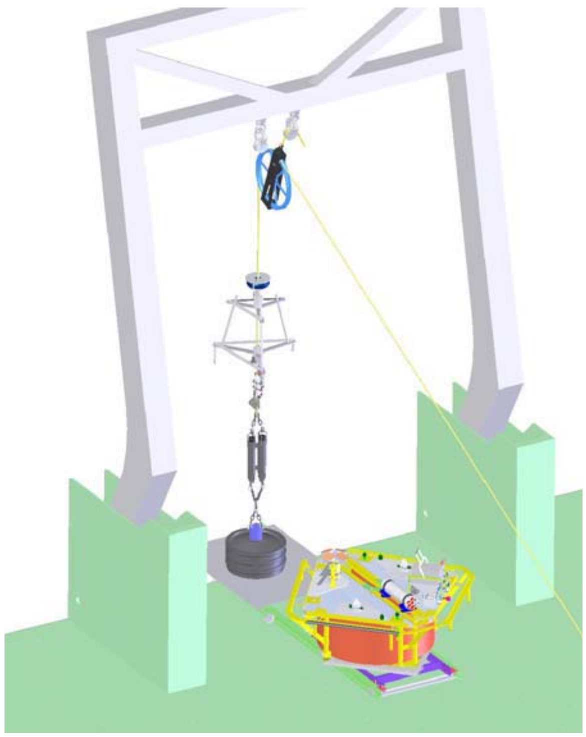


Figure 18. Ready to lower anchor

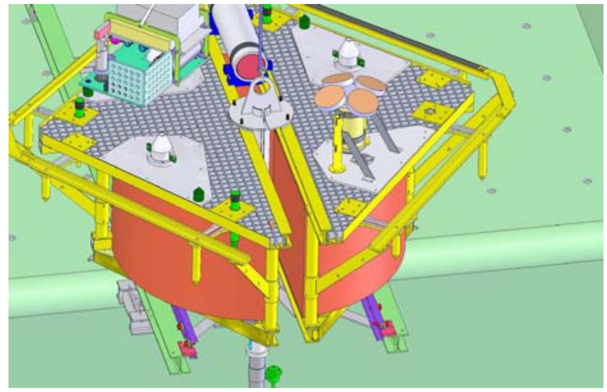


Figure 19. Titanium center post, clamped to track frame and bolted in float slot

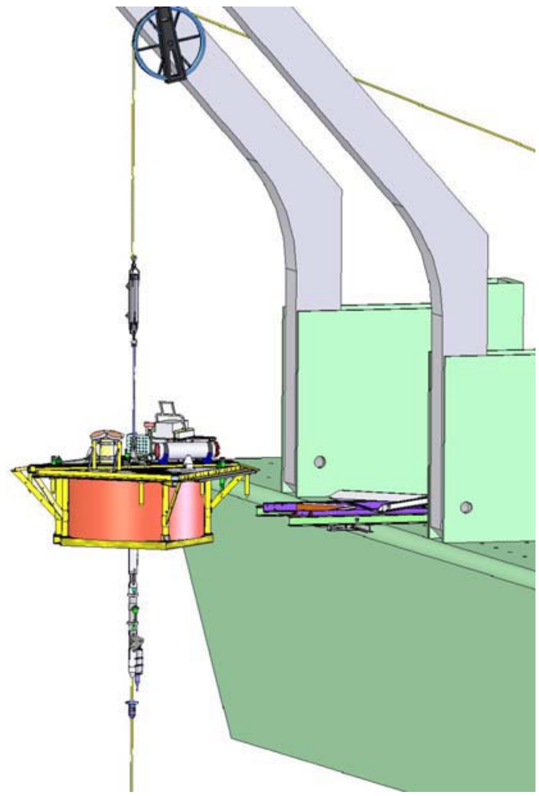


Figure 20. Lowering the float

After the cruise and demobilization, work will continue at a low level on refining the software, verifying smooth flow of data, interaction with MBARI and UH regarding data management, archiving and analysis.

We originally intended to conduct one service call mid-way through using an ROV, but given the budget constraints this is no longer planned.

The recovery vessel and schedule is not yet known. For planning purposes, we assume it will be the R/V *Thompson*, loading in San Diego and ending in Seattle in September 2008. Again, a MBARI ROV will be used to disconnect the mooring and recover the seafloor equipment.

After final recovery, all the system documentation will be finalized, and the final project report submitted.

Project tasks and effort to completion

	Task	Approx effort/cost
Phase 1		
FY2007		
June 2007	Test profiler on R/V *Miller* in 100 ft	80days, $25k *Miller*
June - Sep 2007	Install, test, debug, service mooring at Seahurst using the *Miller* (10 days)	
Phase 2		
	Repair and refurbish	
FY2008		206 days, $134k ROV
13-14 Nov 2007	Deploy MARS seafloor cable	
1-20 Apr 2008	Deploy cruise, Seattle-Monterey-San Diego	
1–15 Sep 2008	Recovery Cruise	
30 Sep 2008	End of project	

Risk

Several decisions have been made during the course of the project to reduce risk.

Being able to easily visit and service the system in Puget Sound has been crucial. Setting up a complete test system in Puget Sound has turned out to be a very positive decision. Having it close to home, not at VENUS as originally proposed, and in diver serviceable depths, using a lower cost vessel has been very effective in debugging the system. In the current draft supplemental request budget we have included enough vessel time for several deploy/test/recover cycles to give us the opportunity to test the inevitable necessary fixes from the first.

From an engineering perspective (especially given our present, better knowledge and understanding of the state of the art of this type of work), testing this mooring system for the first time in open ocean at MARS is much preferable to doing so at ALOHA. Using MARS opens up access to the MBARI ROVs with their flexibility in schedule (compared with ROV Jason) and experience with cable and mooring systems. It is important to note that ROV *Jason* has not developed cable laying capability as originally expected; this requires the use of the MBARI ROVs. MBARI has been laying similar small diameter secondary cables for several years now. If a problem develops, there is at least a chance to fix it whereas the lack of a readily assessable ROV in Hawaii would make this impossible. Installing the system in two distinct steps at MARS (seafloor cable, secondary node, instrument package and then mooring) reduces the risk, since if a problem arose with the seafloor portion of the system, it could be repaired before the mooring was installed. The very explicit purpose of MARS is to test sensor network infrastructure and instruments as we will do.

The present cruise request is for 20 days. Assuming 7 days for transit leaves 13 days on station, adequate for contingencies (such as recovering, repairing, and redeploying, and weather).

Related work and projects

As has been already mentioned, MBARI will be taking responsibility for data from the fixed sensors ($CTDO_2$, BB2F, and ADCP).

The NASA project "A Smart Sensor Web for Ocean Observation: System Design, Modeling, and Optimization" funded by the Advanced Information Systems Technology program, with Payman Arabshahi as PI (Howe is a co-PI), will be developing an open source network protocol for the WHOI micromodem (or any acoustic modem, in general). This will be tested in 2008 in Monterey Bay using several gliders with modems flying around the AMM system. Yi Chao (JPL) is also a co-PI and will be assimilating much of the data from all sensors into his ocean modeling and prediction system. Lee Freitag (WHOI) is assisting with the modems, and as part of his NSF grant, "Acoustic communications for seafloor observatories," will be installing an "all digital" modem on the MARS node.

Tom Sanford (UW) and Doug Luther (UHawaii) are working to deploy their recently developed HPIES (horizontal electric field, pressure, inverted echosounder) on the AMM seafloor secondary node; it is important to be far from any sea ground, specifically the MARS primary node sea ground. John Horne (UW) has just received a state-of-the-art scientific marine echosounder from Simrad and is working to prepare it to also attach to our seafloor node. Simrad has donated this instrument.

If the system proves itself, Chris Scholin (MBARI) will install his environmental sample processor (ESP) on the subsurface float.

NSF has recently funded a proposal (Matthew Alford, PI) to develop an autonomous version of this profiler mooring. It will depend on much of the technology developed here, especially the inductive power system.

Lastly, this work directly contributes to the NSF ORION program objectives for moorings in the global, regional and coastal scale components. For instance, the ORION March 2007 Concept Network Design document calls for nine such moorings for the coastal component Pioneer and Endurance arrays, four for the regional cabled observatory, and one for the global component. At the recent June 2007 ORION Observatory Steering Committee meeting, moorings of the type we are developing here were strongly endorsed – significant power and communications capability in the water column are essential for the envisioned transformational science.

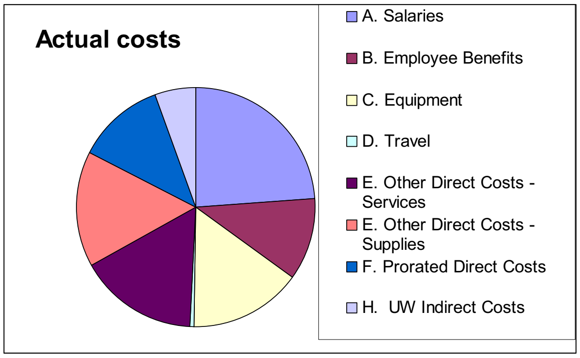
To support the budget process associated with ORION, we have estimated replication cost for this mooring. The hardware and component cost for the entire mooring (without sensors) is $448k. This includes: 2000 m extension cable, 1000 m mooring cable, 1 float, 1 profiler, 2 secondary nodes, ROV-mateable connectors, etc. The estimated labor time and cost is 15 months at $15/month, about $230k. This gives a total replication cost of $678k. Any testing, e.g., in Puget Sound, is not included. Sensors are not included in this cost. We have spent $116k on sensors from this project: dual Seabird CTDO2 sensors (5 at $12k ea), optical sensors (3 at $5k ea), a 150 kHz ADCP ($38k), and a camera ($3k). The hydrophone ($13k) and the modems (2 at $13k ea) were paid for by other projects. Thus, all deployed sensors cost $155k. All of these together – "sensor network infrastructure" and sensors – give a grand total of $833k.

Financial Status

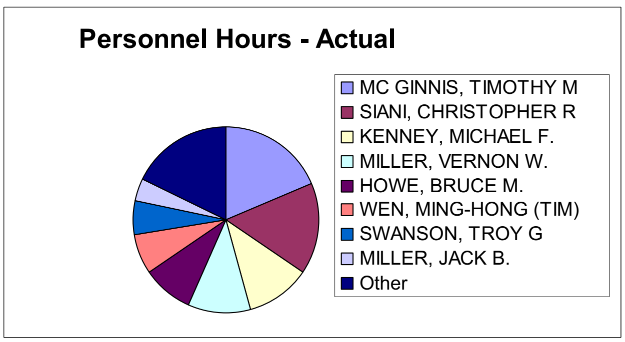
The following figures and tables show the actual expenditures versus time and personnel time and cost as of May 2007. Budgets are shown in a format that breaks out APL pro-rated direct costs ("internal" overhead on salaries, Category F, 47.9%) and UW Indirect Costs (Category H, 17%). (Salaries × ~2.3 gives total cost.)

In May 2004, a rebudgeting occurred, creating two budgets, one for "non-fabrication" and one for "fabrication" (these are combined in the pie charts/tables). At the UW, this means that all direct costs (labor, travel, services, supplies, pro-rated-direct cost) associated with fabrication does not carry the 17% UW overhead (Category H), with a savings to the project of $160,312. At this time we put $220k into a "contingency" fund. This rebudgeting shifted some costs that were originally equipment into services/supplies since the latter were used to "fabricate" equipment built in-house.

The expenditures are shown in the following line graphs. As time progressed the effort in the fabrication portion was bolstered with transfers from non-fab (including from contingency). In June 2006, NSF was informed that a supplement would be necessary. The balance as of 13 June 2007 is $27k; these funds are currently being used for testing the profiler in Puget Sound and installing the test mooring.

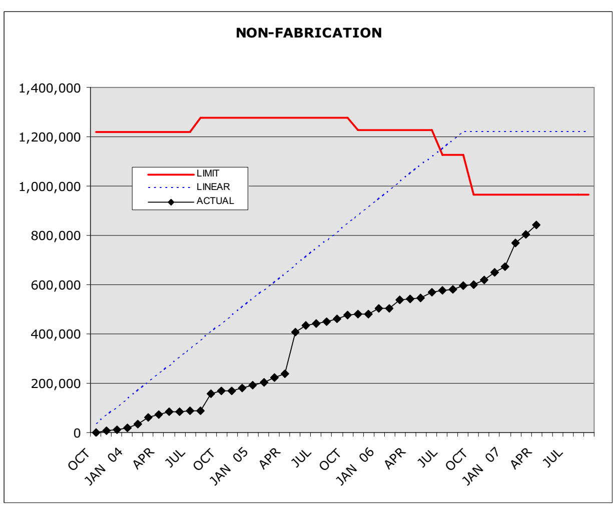


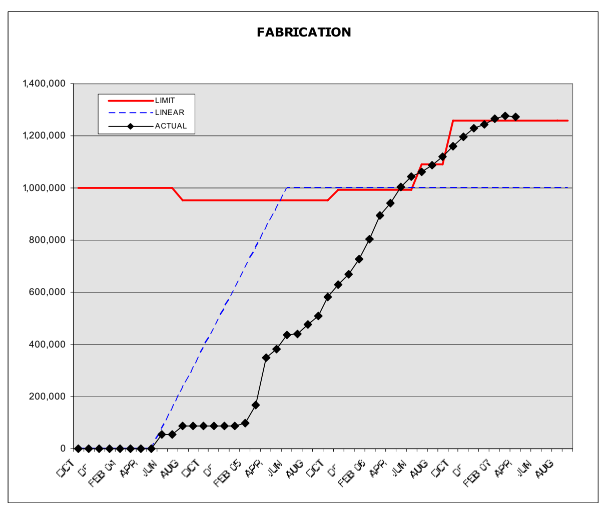
Cost Category – Actual costs	$	fraction
A. Salaries	500,369	0.23
B. Employee Benefits	232,855	0.11
C. Equipment	317,809	0.14
D. Travel	15,750	0.01
E. Other Direct Costs - Services	337,433	0.15
E. Other Direct Costs - Supplies	321,405	0.15
F. Prorated Direct Costs	250,061	0.11
H. UW Indirect Costs	117,907	0.05
Total (fraction of $2,200,000)	2,093,589	0.95



Name – Actual	Hours	Cost $
Tim MC GINNIS, OE	2099.0	110,787
Chris SIANI, EE	1790.0	47,547
Mike KENNEY, SE	1271.0	57,087
Vern MILLER, ME	1240.2	70,269
Bruce HOWE, PI	1003.0	65,950
Tim WEN, SE	777.5	42,860
Troy SWANSON, FE	651.5	20,140
Jack MILLER, EE	437.0	25,488
Other	2013.9	59,653
Total	11283.1	499,781

SE=software engineer, FE=field engineer





References

Project

The project web page: http://alohamooring.apl.washington.edu, with publications (see below), project event log, proposal in the documentation section under project/proposal, system description, status report (16 June 2007) and many of the engineering documents, are on the same web page under Docs_Under_Config_Control

Software documentation wiki http://aloha.apl.washington.edu/wiki/index.php/Main_Page

Seahurst Observatory http://seahurst.apl.washington.edu.

Seahurst Observatory AMM data http://seahurst.apl.washington.edu/mars

Publications available on project web page:

Howe, B. M., P, Arabshahi, W. L. J. Fox, S. Roy, T. McGinnis, M. L. Boyd, A. Gray, and Y. Chao, "A Smart Sensor Web for Ocean Observation: System Design, Architecture, and Performance," *2007 NASA Science Technology Conference (NSTC2007)*, University of Maryland, 19-21 June 2007 *(2,024 KB PDF)*

B. M. Howe, T. McGinnis, and M.L. Boyd, "Sensor Network Infrastructure: Moorings, Mobile Platforms, and Integrated Acoustics," *Symposium on Underwater Technology 2007 and Workshop on Scientific Use of Submarine Cables & Related Technologies 2007*, University of Tokyo, 17-20 April 2007 *(485 KB PDF)*

Howe, B. M., "Moorings for Ocean Observatories: Continuous and Adaptive Sampling," *Elements of Sensor Network Infrastructure: Moorings, Mobile Platforms and Integrated Acoustics*, San Francisco, CA, December 2006 *(59,912 KB PDF)*

Howe, B. M., T. McGinnis, J. Gobat, "Moorings for Ocean Observatories: Continuous and Adaptive Sampling," *Proceedings, the Scientific Submarine Cable 2006 Conference*, 172-181, Marine Institute, Dublin Castle, Dublin, Ireland, 7-10 February 2006 *(64 KB PDF)*

Howe, B. M., T. McGinnis, J. Gobat, "Moorings for Ocean Observatories: Continuous, Adaptive Profiling," *Poster, The Oceanography Society, 2005 International Ocean Research Conference*, Paris, France, June 2005 *(18,152 KB PDF)*

Howe, B.M., T. McGinnis, "Sensor Networks for Cabled Ocean Observatories," *Proceedings, 2004 International Symposium on Underwater Technology*, 113-120, IEEE, 2004 *(1,737 KB PDF)*

Howe, B. M., T. McGinnis, "Sensor networks for cabled ocean observatories," *Proceedings, the Scientific Submarine Cable 2003 Workshop*, 216-221, University of Tokyo, 25-27 June 2003 *(40 KB PDF)*

ORION

Science plan http://www.orionprogram.org/PDFs/OOI_Science_Plan.pdf

Concept network design http://www.orionprogram.org/capabilities/cnd.html

Daly et al. concept proposal on water column science in the regional cabled observatory, http://www.orionprogram.org/RFA/Proposals/Daly.pdf

Regional Scale Nodes

BOE Cover Sheet

Document Number	**4140-00012**
For:	
Type:	NSF Report
Date:	
Company:	
Requested By:	

Notes: The spreadsheet shows the breakout of the replications cost for the Aloha Mooring described in 4140-00011

	Qty	Cost	Ext	Modules	Labor $20k/mo		Assembly Labor $15k/month	Actual Materials	Actual Modules
Cables									
Media Converters	4	8,000	32,000			x			
Extension Cable	1700	10	17,000			x		30,538	
Extension Cable Termination	2	2,000	4,000			x			
ROV Connectors	~~4~~	4,500	18,000			x		15,784	
Mooring Cable	1000	22	22,000			x		57,836	
Mooring Cable Termination	~~2~~	6,000	12,000	105,000	20,000	x	15,000		104,158
Float								5,300	
Foam	1	20,000	20,000			?			
Structure	1	25,000	25,000			?			
Swivel/Sliprings	1	12,000	12,000	57,000	20,000	x	30,000		5,300
Mooring									
Anchor	1	5,000	5,000			?			
Releases	2	17,500	35,000	40,000	10,000	x	7,500		-
MMP									
Basic System	1	75,000	75,000			x		148,610	
Modifications	1	25,000	25,000			?			
Inductive Data Transfer	1	3,000	3,000	103,000	20,000	x	30,000		148,610
Seafloor Secondary Node								41,012	
Frame	1	15,000	15,000			?		53,007	
Pressure Housing	1	10,000	10,000			?			
Internal Chassis	1	3,000	3,000			x			
ROV Mate Receptacles	5	8,500	42,500			x		35,524	
Enet Switch	1	1,200	1,200			x			
DC-DC Conv	1	5,000	5,000			x			
GFM	1	1,000	1,000			x			
Controller	1	5,000	5,000			x			
Timing	1	1,000	1,000	83,700	30,000	x	45,000		129,543
Float Secondary Node								38,937	
Pressure Housing	1	10,000	10,000			?			
Internal Chassis	1	3,000	3,000			x			
ROV Mate Receptacles	3	8,500	25,500			x		9,702	
Enet Switch	1	1,200	1,200			x			
DC-DC Conv	1	5,000	5,000			x			
GFM	1	1,000	1,000			x			
Controller	1	5,000	5,000			x			
Timing	1	1,000	1,000	51,700	30,000	x	45,000		48,639
Video Camera									
Video Server									
SIIMs (includes 2 units)									
Frame	2	5,000	10,000			?			
Pressure Housing	2	10,000	20,000			?			
Internal Chassis	2	3,000	6,000			x			
Dry Mate Connectors	16	250	4,000			x			
ROV Cable	2	5,000	10,000			x		3,946	
Enet Switch	2	1,200	2,400			x			
Controller	2	2,500	5,000			x			
Xports	16	100	1,600			x			
Motherboard	2	1,000	2,000			?			
DC-DC Conv	2	2,000	4,000			x			
Video Server	1	500	500	65,500	40,000	x	15,000		3,946
Power								7,012	
DC-HFAC	1	3,000	3,000			?			
HFAC-DC	1	2,000	2,000			?			
Battery Charger	1	1,200	1,200			x			
Battery Pack	8	165	1,320			x			
Coupler	1	5,000	5,000	12,520	20,000	?	30,000		7,012
Sensors									
ADCP	1	40,000	40,000			x		37,500	
CTDO	5	12,000	60,000			x		58,537	
Video Camera	1	2,500	2,500			x		2,585	
BB2F	3	5,500	16,500	119,000	10,000	x	15,000	15,612	114,234
Total			637,420	637,420	200,000		232,500	561,442	561,442
Rounded Up ??			750,000		250,000	?	250,000		600,000
Total					1,000,000				850,000

winch info to Marv

RSN Deep Profiler Spares Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Modules	Est Labor (20k/mo)	Total With Labor	Quote List	Detail
Deep Profiler Vehicle								
MPP	1	$ 80,000	$ 80,000					
Controller	1	$ 2,000	$ 2,000					
Sensors	1	$ 7,000	$ 7,000					
Conector	1	$ 7,500	$ 7,500					
Batteries	1	$ 5,000	$ 5,000					
Inductors	1	$ 10,000	$ 10,000					
Misc	1	$ 10,000	$ 10,000	$ 121,500	$ 90,000	$ 211,500		
Test					$ 50,000	$ 50,000		
Dock and Mooring System								
Extension Cable	2000	$ 25	$ 50,000					
ROV Connectors	2	$ 35,000	$ 70,000					
FACTs	2	$ 10,000	$ 20,000					
Mooring Float	1	$ 20,000	$ 20,000					
Mech Cable	2900	$ 7	$ 20,300					
Anchor	1	$ 16,000	$ 16,000					
Acoustis Releases & Frame	1	$ 45,000	$ 45,000					
Pressure Housing	1	32,000	$ 32,000					
Cables & Connnectors	1	10,000	$ 10,000					
Inductive Power System	1	2,500	$ 2,500					
Power Coupler	1	8,000	$ 8,000					
RF Comms	1	10,000	$ 10,000					
Inductive Comms System	1	2,000	$ 2,000					
Misc	1	60,000	$ 60,000	$ 365,800		$ 365,800		
Sub Totals			$ 487,300	$ 487,300	$ 140,000			
Total Mooring System						**$ 627,300**		

	Name	Signature Field
Doc Num	**4140-64538**	
Estimated By		
Revision	**1-00**	
Date	**5/4/2011**	
Approved By		
Date		

RSN Shallow Profiler Spares Basis of Estimate Sheet

Item	Qty	Est Cost	Ext	Modules	Est Labor (20k/mo)	Total With Labor	Quote List	Detail
Shallow Profiler								
Structural Ti, fasteners.	1	$ 20,000	$ 20,000					
Drum	1	$ 20,000	$ 20,000					
Slip Ring	1	$ 13,700	$ 13,700					
Pressure Compensator	1	$ 26,000	$ 26,000					
SciPod Housing	1	$ 36,000	$ 36,000					
Switch DSL	1	$ 7,000	$ 7,000					
Frame	1	$ 54,000	$ 54,000					
Pressure Sensors	2	$ 10,000	$ 20,000					
VFD Housing	1	$ 36,000	$ 36,000					
VFD Housing	2	$ 3,100	$ 6,200					
Data Housing	1	$ 36,000	$ 36,000					
ROV Wet Mate Receptacle	1	$ 10,000	$ 10,000					
ROV Wet Mate Cable	2	$ 10,000	$ 20,000					
Eng Pressure Sensor	1	$ 20,000	$ 20,000					
Video Camera	1	$ 10,000	$ 10,000					
Switch DSL	1	$ 7,000	$ 7,000					
Motor Housing	1	8,000	$ 8,000					
Resistor Housing	1	18,000	$ 18,000					
Machine Shop	1	188,000	$ 188,000					
Misc	1	80,000	$ 80,000	$ 635,900	$ 226,000	$ 861,900		
Test					$ 52,000			
Sub Totals			$ 635,900	$ 635,900	$ -			
Total Mooring System						**$ 861,900**		

	Name	Signature Field
Doc Num	**4140-64539**	
Estimated By		
Revision	**1-00**	
Date	**5/4/2011**	
Approved By		
Date		

RSN Instrument Module VM Spares Basis of Estimate Sheet

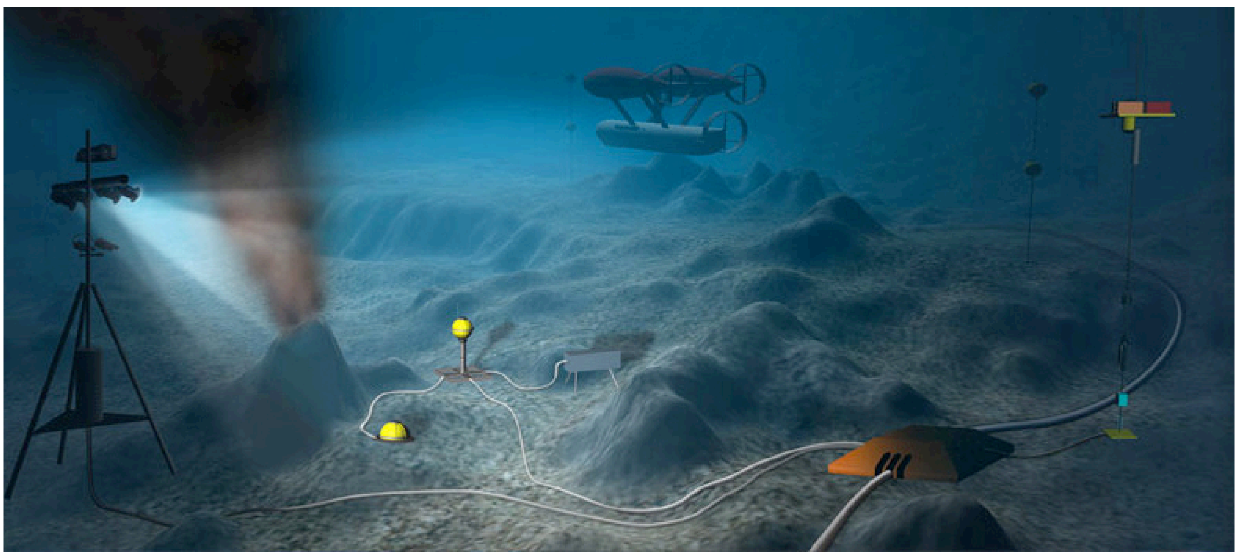
Item	Qty	Est Cost	Ext	Modules	Est Labor (20k/mo)	Total With Labor	Quote List	Detail
Mooring Controller								
UW APL Node LVNode Equip Misc	1	$ 43,000	$ 43,000				4140-00016	
UW APL Node LVNode Pressure Hou	1	$ 36,000	$ 36,000				4140-00016	
ROV Electrical Con	2	$ 10,000	$ 20,000				4120-00001	
ROV Hybrid Con	1	$ 35,000	$ 35,000				4120-00001	
LVNode Frame	1	$ 20,000	$ 20,000	$ 154,000	$ 60,000	$ 214,000		
200 Meter Jbox								
Jbox Base Equipment Misc	1	$ 20,000	$ 20,000				4140-00014	
Jbox Pressure Housing	1	$ 16,000	$ 16,000				4140-00014	
Dry Mate Con	8	$ 500	$ 4,000				4120-00004	
Jbox Frame	1	$ 20,000	$ 20,000	$ 60,000	$ 30,000	$ 90,000	4140-00001	
Sub Totals			$ 214,000	$ 214,000	$ 90,000			
Total Mooring System						**$ 304,000**		

	Name	Signature Field
Doc Num	**4140-66399**	
Estimated By		
Revision	**1-00**	
Date	**5/4/2011**	
Approved By		
Date		

Mooring Controler and Float Junction Box Have same components and MPJbox and LPJBox - Details of sub components can be found on those BOE documents.

OOI-Regional Scale Nodes PN1A Mooring Deployment Scenario

Version 1.0



Prepared by
University of Washington for the
Ocean Observatories Initiative
April 18, 2011

Document Number 4315-66407

Document Control Sheet

Version	Release Date	Description	By
1.0		Initial Version	D. Kelley

Table of Contents

1.0 Introduction

This document presents a scenario for installation of the full water column mooring and associated benthic sensors at the primary node located near the base of the slope west of Southern Hydrate Ridge.

2.0 Assumptions

It is assumed that the ROV ROPOS is used for this installation and that the R/V Thompson is the host ship. It is also assumed that the ROPOS vans are stacked, and that the optical winch and traction winch for the mooring are both on the fan tail. The ship is first mobilized in Seattle at the University of Washington School of Oceanography dock, and then transits to Esquimalt Harbor, Victoria for mobilization of ROPOS. Mobilization time at Victoria is based on estimates from the Canadian Scientific Submersible Facility.

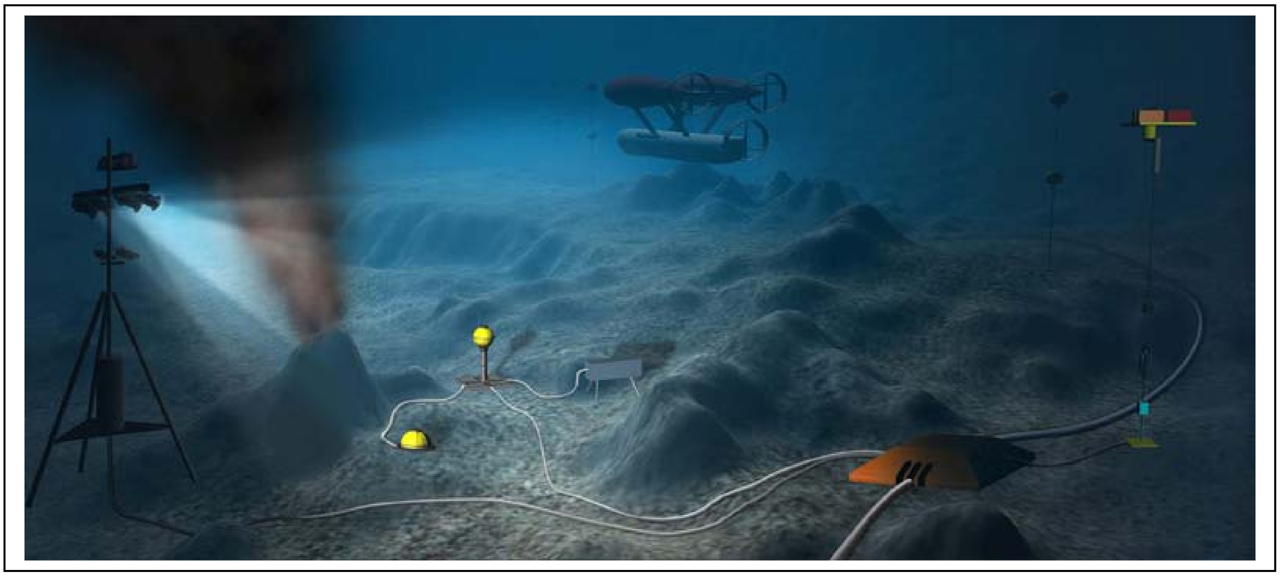
3.0 Installation Scenario

System Wide Assumptions

	Mooring Deployment PN1A Slope Base Equipment to Mobe TASKS	**Time (hrs)**
1	Steam to Victoria to mobilize ROPOS	15
2	Mobilize ROPOS	48
3	Steam to PN1A	36
4	Deploy PN1A Moorings	120
5	Deploy ROPOS and dive to mooring location	2
6	Inspect mooring locations	6
7	Recover ROPOS	2
8	Mount ROPOS with ROCLS and transit ship to PN1A	4
9	Deploy ROPOS with ROCLS and 1 km cable, lower to 2900 m	2
10	Drop ROCLS and connect 1 km cable to PN1A	3
11	Acquire ROCLS	8
12	Spool 1 km cable to connect to LV01A	1.5
13	Recover ROPOS	2
14	Mount LV01A to ROPOS w/Opt Att., CTD, ADCP, Hydrophone	3
15	Deploy ROPOS with LV01A, lower to 2900 m	2
16	Deploy LV01A	3
17	Connect 1 km cable from PN1A to LV01A	3
18	Acquire 100 m cable from EOM FACT on mooring-splayout to LV01A	1
19	Connect 100 m cable from EOM FACT mooring to LV01A	3
20	Transit to Deep Profiler mooring	1
21	Acquire 70 m extension cable connected to Deep Profiler docking stn	1
22	Transit to LV01A and connect DP extension cable	3
23	Recover ROPOS	2
24	Mount ROCLS with 500 m HPIES extension cable	4
25	Deploy ROPOS w ROCLS	2

26	Drop ROCLS and connect 500 m cable to LV01A	3
27	Remount ROCLS	6
28	Deploy 500 m cable	1.5
29	Recover ROCLS	2
30	Mount HPIES on ROPOS porch	3
31	Deploy ROPOS	2
32	Deploy HPIES	1
33	Connect 500 m cable to HPIES	3
34	Recover ROPOS	2
35	Mount LP-J-Box to ROPOS with current meter, pressure sensor	3
36	Deploy ROPOS with LP-J-Box and lower to 2900	2
37	Deploy LP-J-Box with current meter, pressure sensor	2
38	Recover ROPOS and prepare for BB deployment	10
39	Deploy ROPOS to LP-J-Box with Caisson	2
40	Blow out Caisson hole	4
41	Recover ROPOS	2
42	Mount broadband sensor and battery frame	3
43	Deploy ROPOS	2
44	Deploy Frame	1
45	Deploy broadband in caisson	1
46	Cover caisson with silica beads	3
47	Connect extension cable from LP-J-Box to battery frame	2
48	Power system up and check out	3
49	Recover ROPOS	2
50	Conduct 1 CTD casts	3
51	Power up system and commence check out	6
52	Conduct 1 CTD casts	3
	Total Hours	355

OOI-Regional Scale Nodes
Installation Planning Scenario
Hydrate Ridge
Version 1-01



Prepared by
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Ocean Observatories Initiative
Oct 1, 2008

Document Control Sheet

Version	Release Date	Description	By
1.0		Initial Version	M. Harrington
1-01	10/1/08	Update Formatting ROPOS info	M. Harrington

Table of Contents

1. Introduction

This document presents a scenario for installing the Secondary Infrastructure at the Hydrate Ridge Site. This scenario can be utilized to identify resources needed for the installation and as a Basis of Estimate for the cost book and integrated master schedule.

2. System Wide Assumptions/Terms

RSN Primary Infrastructure –

RSN Secondary Infrastructure –

RSN Hybrid Profiling Mooring –

ROPOS – www.ropos.com

Paper on Cable installation with ROV http://www.ropos.com/documents/ROCLS%20paper.pdf (see bullet list of procedure at end of this document)

3. Installation Scenario

This scenario describes the steps required to install the Secondary Infrastructure at Hydrate Ridge.

Assumptions:

- The entire RSN Primary Infrastructure has already been installed, commissioned and operational for 1 year.
- There is no Secondary Infrastructure installed at the Hydrate Ridge Site.
- This covers only the Secondary Infrastructure at Hydrate Ridge and not equipment that is part of the Endurance Sites.
- All Secondary Equipment has been fully integrated and tested and shipped to a staging area in Newport, Oregon.
- The UW UNOLS vessel Thompson has been scheduled for exclusive use for this installation mission.
- The ROPOS ROV and operators have been scheduled for exclusive use for this installation including all necessary equipment including multiple cable installation reels, tools to blow out holes for seismometers cranes and manipulation tools.
- Assume Cable Ship with ROV has previously installed 10km Cable from PN01B to Southern Summit and Plugged into Dummy Connector/Frame.

Initial State:
The Primary Infrastructure is powered on and in a normal state with no known issues. The Thompson has arrived at the Newport staging area and has previously been fully offloaded from its previous mission.

4. Install Mooring Cable

Because of limited deck space the Mooring Cable will be installed before the ROPOS and its equipment is loaded on to the ship. In this case the Mooring Cable with 200 Meter Platform/Winch and Sensors/Anchor/ Acoustic Release will all be installed at the Site and then later will be connected to the system after the rest of the secondary infrastructure is installed by the ROV.

<u>Step 1</u> The Thompson will be loaded with the following pre-integrated equipment:

- 3km Mooring Cable with Anchor/Acoustic Release system at one end and (10mx10mx 2m) 200 Meter Platform at the other end. The cable will be coiled in a cable box on the ship by hand.
- 400 Volt/Ethernet LVNode Simulator.
- CI Remote Workstation.
- Spare Sensors/Connectors/Cables.
- Sensor Calibration/Test/Sampling Equipment

Mob 2 Days

<u>Step 2</u> The Thompson will have TBD on board staff personnel. In addition there will be:

PI (1)
Staff Scientists (2)
PI Scientist (2)
Field Engineers (4)
Engineers (3)
PM (1)
Operations Center Specialist (1)
CI rep (1)
OL rep (2)
NSF Rep (2)
UW rep (2)
Document/Web Support (2)

<u>Step 3</u> The Thompson will transit to location to install mooring.

While in transit the Mooring will be tested with the LV Node simulator to verify functionality.

Transit to Site /Test Half Day.

<u>Step 4</u> The Thompson will stay on station above mooring base location based on previous surveys and GPS tracking.

The Mooring will go through final checkout and any covers/installation steps/connections will be performed.

The PI will give final go ahead to begin procedure.

The Field Engineers will play out cable end with anchor and anchor releases with connector back up along cable off the end of the ship using a winch with rope attached to anchor to control deployment. A homer beacon will be installed on connector for use by ROV.

A Crane will drop 200 Meter Platform over end of Thompson.

Mooring Cable Install 2 Days

<u>Step 5</u> The Thompson will transit back to Newport.

Transit back to Newport Half Day

Install Mooring Cable Total = 5 Days

<u>Total Running -Time 10 Days</u>

5. Mobilize ROPOS ROV + RSN Equipment

Now the Thompson will be loaded with all of the Materials needed for the rest of the scenario and the ROPOS ROV.

Items to be loaded on Thompson:

- ROPOS Equipment:
  - Crane loaded and attached to deck floor.
  - ROV Winch System loaded and attached to deck floor.
  - 20 Foot Equipment Van
  - Control Electronic Systems Loaded into Science Room on Thompson
  - Cabling Run for system
  - System Checked
  - Tools for blowing out holes for Seismometers

- ROPOS Personnel: Staff of 8

- RSN Equipment: (For Mooring and Core Locations)
  - 1 Cable Drum preloaded with 4.5km Cable to Mooring Base
  - 1 Cable Drum preloaded with 1km Cable to Hydrate Base
  - 500 Meters Cable For HPIES (On Drum)
  - 2 – (3mx3m Junction boxes with Connected Sensors/Interface Boxes/Cables)
  - LV Node (1.5x1.5m)
  - Profiler
  - HPIES (2mx2m?)
  - Spares? Sensors?-JBox?-Frame?-Cables?-Connectors?

Ropos Mob 3 Days

Total Running -Time 13 Days

Notes:

- It was estimated that after ROPOS was loaded on Thompson, no more than 3 – 3mx3m benthic platforms could be comfortable loaded.
- There is room at front of Thompson for containers on the aft deck but no Crane support to move/deploy large systems from there.
- Estimated a ROPOS Cable Drum with 4km of cable is 1.5mx1.5mx1.5m

6. Connect Mooring to Primary Infrastructure

Step 1 Transit to Site

Transit to Site Half Day

Step 2 Attach Rope on Winch system to LVNode. Lower LVNode to Mooring Site and recover cable.

2 hours

Step 3 Attach Cable Drum with 4.5 km cable to ROPOS. (while LVNode is lowered)

Step 4 Lower Ropos to SeaFloor near Mooring Anchor.

2 hours

Step 5 Fly Drum to desired LVNode Site

Step 6 Detach from Drum

Step 7 Locate LVNode (beacon?)

Step 8 Move LVNode to desired location

Step 9 Plug Cable from Drum to LVNode

Step 10 Secure Cable to LVNode (to prevent cable pulling on connector during install)

4 hours

Step 11 Attach ROPOS to Drum

Step 12 Fly ROPOS and Ship to Primary Node (4.5km at 0.5 knots)

10 hours

Step 13 Plug into Primary Node. Assumes Hydrate Line is Powered Off

1 hour

Step 14 Attach ROPOS to empty DRUM

Step 15 Recover ROPOS

2 hours

Step 16 Turn ROPOS

4 hours

Step 17 Coordinate with Ops Center to Turn on Power to Primary Node

1 hour

Step 18 Shore Based Ops Center tests LVNode

2 hours

Step 19 Shore Based Ops Center tests Mooring

6 hours

If debugging uncovers problems, do we debug now or go on with rest of install?

Total 2 Days

Total Running -Time 15 Days

7. Install Sensors at base of Mooring

Step 1 Turn Power Off to System

Step 2 Drop Junction Box Platform with 6 Sensor on 10 Meters Cable Each using 3km tow line on winch

2 hours

Step 3 Recover Tow Line

2 hours

Step 4 Drop HPIES using 3km tow line on winch

2 hours

Step 5 Recover Tow Line

2 hours

Step 6 Lower Ropos with Drum and 500 Meter cable for HPIES

2 hours

Step 7 Detach from Drum

Step 8 Position JBox Platform Next to LVNode

Step 9 Plug 10meter Cable between LVNode and JBox

2 hours

Step 10 Position Sensors (CTD/ADCP/Optical Backscatter/Flourometer attached to Frame) Hydrophone moved away.

30 minutes

Step 11 Attach to HPIES Platform.

Step 12 Move 500 Meters away to Locate HPIES

1 hour

Step 13 Fly ROPOS back to Junction Box Location

1 hour

Step 14 Plug HPIES Cable into Junction Box – Mechanically secure cable to Jbox Frame

30 minutes

Step 15 Attach to Cable DRUM

Step 16 Install 500 meter cable between Junction Box and HPIES

1 hour

Step 17 Detach from DRUM

Step 18 Plug Cable into HPIES Platform

30 minutes

Step 19 Attach to Cable DRUM

Step 20 Drive Back to Junction Box

1 hour

Step 21 Detach from DRUM

Step 22 Fly Up to 200 Meter Platform

2 hours

Step 23 Pick up Profiler from temporary location on 200 meter platform

Step 24 Install on Mooring Cable

1 hour

Step 25 Fly Down and Pick up Used Cable Drum

2 hours

Step 26 Recover Empty 500m HPIES Cable Drum

4 hours

Step 27 Recover Empty 4500m LVNode Cable Drum

4 hours

Total 34 hours

Probably should Recover ROPOS and Check out/Rest for 12 hours.

Total Running -Time 16 Days 10 hours

8. Install Hydrate Core Sensor Package

Step 1 Lower Cable Drum with 1km using tow line?

2 hours

Step 2 Recover tow line?

2 hours

Step 3 Lower Junction Box with Sensors using tow line

2 hours

Step 4 Recover Tow line

2 hours

Step 5 Attach ROPOS to Junction Box Platform and locate as needed.

30 minutes

Step 6 Attach to Cable DRUM

Step 7 Fly Next to Junction Box

Step 8 Detach from Cable DRUM

Step 9 Connect Cable to Junction Box and mechanically secure cable to Junction Box Frame

2 hours

Step 10 Attach to Cable DRUM

Step 11 Install 1000 meter cable between Junction Box and Primary Node

3 hours

Step 12 Detach from DRUM

Step 13 Plug Cable into Primary Node

30 minutes

Step 14 Attach to Cable DRUM

Step 15 Recover ROPOS and Cable Drum

3 hours

Total 17 hours

Total Running -Time 17 Days 3 hours

9. Install Seismometer

Step 1 Reconfigure/Turn ROPOS for blowing out hole.

1 day

Step 2 Deploy ROPOS to Seafloor.

2 hours

Step 3 Simultaneously? Free fall Elevator with glass beads/Caseon.

Step 4 Pick up and Locate Caseon

Step 5 Jump on it to embed in seafloor

Step 6 Blow it out

Step 7 Drop Seismometer in it

Step 8 Fill hole with silica beads

10 hours

Step 9 Recover ROPOS From Seafloor.

2 hours

Step 10 Recover Elevator From Seafloor.

2 hours
Total Turn Time 1 day
Total In Water Time 16 hours

Total Running -Time 18 Days 19 hours

10. Demob/Mob for Southern Summit

Step 1 Transit Back to Newport.

12 hours

Step 2 Unload/Load Equipment – Personnel Change.

1 day

RSN Equipment:
- 1 Cable Drum preloaded with 2 - 250m Cable for Seismometer
- 1 – (3mx3m Junction boxes with Connected Sensors/Interface Boxes/Cables)
- LV Node (1.5x1.5m)
- Profiler
- Short Period Seismometers with Interface Boxes
- Spares? Sensors?-JBox?-Frame?-Cables?-Connectors?

Step 3 Transit Back to Site.

12 hours

Total 2 Days

Total Running -Time 20 Days 19 hours

11. Install Southern Hydrate

Have not converted the minutes from the meeting below yet. Probably another 4-7 days

Drop LVnode 1 hour

Drop MP JBox Frame with all of the sensors

Drop Ropos with Reel

Ropos Drops Reel.

Posisitions the LVNOde next to too seep.

How close does Cable need to be to seep.

What does ROPOS pull on to bring cable next to LVNODe?

Does cable ship leave pulling eye?

Locate Cable

Unplug cable from what ever its been plugged.

Drag to LVNODe

Plug into LVNODe

Move JBox with frame next to seep /LVNOde

Plug JBox in to LVNODe

Get everything off the frame. (Make room around frame for plugging by ROV)

Grab the seismometer in sesimonumount.

Pick up spool.

Connent one end

Pick up spool

Drive
Plug in one

Pick up spool

Drive back to LVNODe

Plug In

Drive back to
Lay the 2 – 250 meter cables (spooled out by ROPOS)

Siesmont
Drop Spool

Plug into Seismomoter

Hour for each sensor.

Summit Southern Hydrates

Drop elevator with glass beads (FIRST)

Another spool with 350meters.

Another Spool with 250 Meters.

Droped the Medium Power Jbox Platform.

Position Jbox

Intall the 350 meter cable

Install sensors

Install 250 meter cable

Recover 3-4 spools,

Recover Ropos

Reconfigure 12-24 hours simulatoes check out of installed sensors.

Go back down.

Put in cason/blow out put in broad band/ cover with beads/ plug it in.

Possible leave Ropos? While Powering.

Water Samples (1 hour)

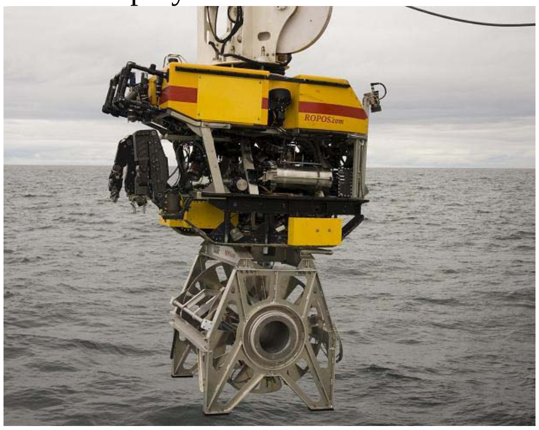
Photograph everything (1 hour – 2 hours)

ROPOS Cable installation process

Launching the system is as easy as positioning the vehicle over the Drum Frame with the LARS, latching and securing the package to the vehicle and deploying the combined system in a fashion similar to normal operating procedures.

The cable lay process itself is best summarized in point form:

- Latch onto ROCLS drum frame with the appropriate drum loaded.
- Lower the complete package over the side.
- Lower the system to the appropriate location on the seafloor and land.
- Unlatch the deployment package; vehicle becomes free swimming.
- Remove one flying lead from the drum and make connection to the node or instrument.
- Secure cable to node with Yale grip to ensure cable cannot pull directly on cable connector during lay process.
- Latch onto Drum Frame and lift off seafloor.
- Move across seafloor laying cable, manoeuvring around obstacles identified with sonar and video cameras.
- Use the vehicle thrusters to deflect the cable touchdown point around obstacles.
- Manage slack and cable tension by controlling payout or even winding cable back onto the drum.
- Monitor cable dynamics with multiple process cameras including lowlight camera on stinger.
- Upon completion of the lay, wind any remaining cable off in a controlled, retrievable fashion.
- Place Drum Frame near the instrument and unlatch
- Land Vehicle alongside Drum Frame on seafloor and remove bitter end of cable with media
- converter can and connector.
- Plug the connector into instrumentation package.
- Fly back and latch into Drum Frame and recover system to load next cable for deployment.



Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00001**
For:	ODI Wet Mate Connectors
Type:	Budgetary Quote
Date:	May 7,2007
Company:	ODI
Requested By:	Tim McGinnis

Notes:

- Budgetary Quotation # 11268 -

Ocean Design is pleased to
offer the following quotation:

Date: 7-May-07

To: University of Washington

Attn: Mr. Tim McGinnis

Re: NEPTUNE US Project

The following pricing includes Ocean Design's standard Factory Acceptance Testing (FAT) in accordance with our latest FAT procedures.

		Budgetary Quote 11268		**Conn/Assy Qtys**		**University of Washington**		
Item	**No. of Line Items**	**Unit**	**ODI Assembly Part Number (Type Designation)**	**Qty Per Line Item**	**TOTAL QTY**	**Line Item Unit Price**	**Line Item Unit Price**	**Line Item Unit Price**
						Qty 1-5	**Qty 6-10**	**11+**
1	1	**Jumper Assembly, High Pressure, 12-Way ROV Bulkhead Receptacle to 12-Way Bulkhead Penetrator, with CAT-5e and 5' Pigtails consisting of:**	1037470 (COS-034-01)			$10,121	$9,741	$9,474
1.1	1	12-Way ROV Bulkhead Fixed Receptacle (Sockets) with 90° JIC Hose Termination - Titanium CP, Gr2 Shell		1	1			
1.2	1	3.35m x 12-Way Fluid Filled Hose Assembly		1	1			
1.3	1	12-Way High Pressure Bulkhead Penetrator with Straight JIC Hose Termination & 1.5m Wire Pigtails with RJ-45 Connector - Titanium CP, Gr2 Shell		1	1			
2	1	**Jumper Assembly, High Pressure, 12-Way ROV Cable End Plug to 12-Way Bulkhead Penetrator with CAT-5e and 5' Pigtails, consisting of:**	1042553 (COS-068-01-2)			$10,338	$9,950	$9,677
2.1	1	12-Way ROV Cable End Plug (Pins) with 90° JIC Hose Termination - Titanium CP, Gr2 Shell		1	1			
2.2	1	10m x 12-Way Fluid Filled Hose Assembly		1	1			
2.3	1	12-Way High Pressure Bulkhead Penetrator with Straight JIC Hose Termination & 1.5m Wire Pigtails and RJ-45 Connector - Titanium CP, Gr2 Shell		1	1			

3	1	**Jumper Assembly, 12-Way ROV Cable End Plug (Pins) to Customer Supplied Cable Assembly, consisting of:**	1037616 (COS-036-01-1)			$6,500	$6,240	$6,053
3.1	1	12-Way ROV Cable End Plug (Pins) with 90° Molded Termination - Titanium CP, Gr2 Shell		1	1			
3.2	1	Cable Assembly, 40' Falmat FMXCAT52218K12 with Integral Subconn Connector, CUSTOMER SUPPLIED MATERIAL (CSM)		1	1			
4	1	**Hybrid Jumper Assembly, 4SM/2E Bulkhead Plug to Penetrator, consisting of:**	similar to 1041200 (OPM-271-01-1)			$32,173	$30,725	$29,650
4.1	1	4SM/2E Rolling Seal Hyrbid Bulkhead Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1			
4.2	1	3m x 4SM/2E Fluid Filled Hose Assembly with Integral Splice Management Canister - Titanium CP, Gr2 Shell		1	1			
4.3	1	4SM/2E Bulkhead Penetrator with 90° Integral Hose Termination and Wire and Fiber Pigtails - Titanium CP, Gr2 Shell		1	1			
5	1	**Hybrid Jumper Assembly, 4SM/2E Cable End Receptacle to Penetrator, consisting of:**	similar to 1041032 (OPM-193-01-2)			$33,173	$31,680	$30,571
5.1	1	4SM/2E Rolling Seal Hybrid Cable End Receptacle (Sockets) with 45º Integral Hose Termination - Titanium CP, Gr2 Shell		1	1			
5.2	1	10m x 4SM/2E Fluid Filled Hose Assembly with Integral Splice Management Canister - Titanium CP, Gr2 Shell		1	1			
5.3	1	4SM/2E Bulkhead Penetrator with Straight Integral Hose Termination and 1.5m Fiber Pigtails Terminated in FC Connectors - Titanium CP, Gr2 Shell		1	1			
6	1	**Jumper Assembly, Hybrid Connector to Customer Supplied Cable Assembly, consisting of:**				$39,499	$37,722	$36,401
6.1	1	4SM/2E Rolling Seal Hybrid Cable End Receptacle (Sockets) with 90° Integral Cable Termination (FITA) - Titanium CP, Gr2 Shell		1	1			
6.2	1	Cable Assembly, Cortland HV506011, with Integrated Connector, CSM		1	1			
7	1	**10kV ROV Bulkhead Fixed Plug to Bulkhead Penetrator Jumper Assembly, consisting of:**	similar to 1041033 (OPM-196-01-2)			$25,674	$24,519	$23,783

7.1	1	4-Way (2 Used) 10kV ROV Bulkhead Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1			
7.2	1	3m x 2-Way 10kV Fluid Filled Hose Assembly		1	1			
7.3	1	2-Way 10kV Bulkhead Penetrator with 90° Integral Hose Termination and 1.5m Wire Pigtails - Titanium CP, Gr2 Shell		1	1			
8	1	**10kV ROV Cable End Receptacle to Bulkhead Penetrator Jumper Assembly, consisting of:**	similar to 1041049 (OPM-194-01-2)			$26,652	$25,453	$24,689
8.1	1	4-Way (2 Used) 10kV ROV Cable End Receptacle (Sockets) with 45° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1			
8.2	1	3m x 2-Way 10kV Fluid Filled Hose Assembly		1	1			
8.3	1	2-Way 10kV Bulkhead Penetrator with Straight Integral Hose Termination and 1.5m Wire Pigtails - Titanium CP, Gr2 Shell		1	1			
9	1	**Jumper Assembly, 4SM Bulkhead Plug to Penetrator, consisting of:**	similar to 1041027 (OPM-195-01-2)			$31,271	$29,864	$28,819
9.1	1	4SM Rolling Seal Bulkhead Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1			
9.2	1	3m x 4SM Fluid Filled Hose Assembly with Integral Splice Management Canister - Titanium CP, Gr2 Shell		1	1			
9.3	1	4SM Bulkhead Penetrator with 90° Integral Hose Termination and 1.5m Fiber Pigtails Terminated in FC Connectors - Titanium CP, Gr2 Shell		1	1			
10	1	**Jumper Assembly, 4SM Cable End Receptacle to Penetrator, consisting of:**	similar to 1041032 (OPM-193-01-2)			$32,109	$30,664	$29,591
10.1	1	4SM Rolling Seal Hybrid Cable End Receptacle (Sockets) with 45º Integral Hose Termination - Titanium CP, Gr2 Shell		1	1			
10.2	1	10m x 4SM Fluid Filled Hose Assembly with Integral Splice Management Canister - Titanium CP, Gr2 Shell		1	1			
10.3	1	4SM Bulkhead Penetrator with Straight Integral Hose Termination and 8m Fiber Pigtails Terminated in FC Connectors - Titanium CP, Gr2 Shell		1	1			

Delivery	General Arrangement Drawings available within 5 weeks After Receipt of Order. Product Delivery to commence within 18 Weeks after Receipt of Customer Approval of General Arrangement Drawings.
Point of Delivery	Ex-Works, Ocean Design Inc, Daytona Beach, Florida
Payment Terms	Net 30 Days From Date of Invoice
Customer Supplied Material	Customer Supplied Material (CSM) is required 8 weeks prior to delivery. Please note that ODI reserves the right to ship in place, transfer title of goods, and invoice for any items which may be withheld from dispatch pending delivery of CSM and/or authorization.

Price includes Certificate of Conformity. Standard QC documentation is provided in electronic format. Paper copies are subject to an additional charge.

Customer Witness/Third Party Inspection may be subject to an additional delivery time and charges at time of order. Please contact ODI for information.

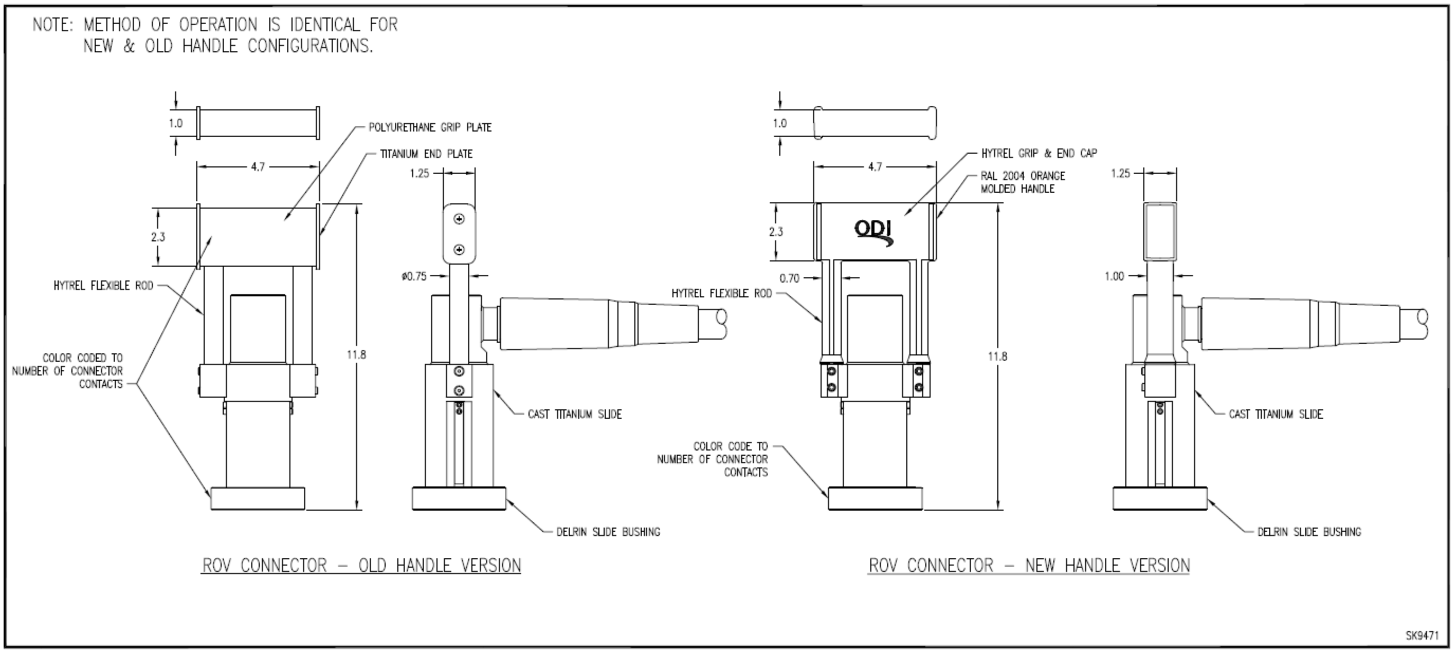
Please Note:- Orders for ROV product resulting from this quotation shall be delivered with ODI's new ROV handle per the attached sketch SK9471.

This Quotation, valid for 30 days, is subject to Ocean Design, Inc. Standard Terms and Conditions of Sale/Rev B - dated 01-May-2004 - that are available on request or from the Sales and Service page of our website at www.odi.com.

Sincerely,
For Ocean Design, Inc.

Jon A. Rinkenberger, Cost and Pricing Analyst

Handle Configuration for all ROV Products that may be referenced by this Quotation



Request for Quotation

Date:	April 27, 2007	RFQ:	RSO070427A

From: Applied Physics Lab
University of Washington
1013 NE 40th St
Seattle, WA 98105
Contact: Tim McGinnis
+1-206-543-1346

To: H.H. Bauer & Assoc.
bauerhh@aol.com

The University of Washington's Applied Physics Lab (APL) has a grant from the National Science Foundation to build a deep ocean oceanographic sensor network. As part of this project, APL requests a cost quotation for the connector components and assemblies described below. All items need to be rated for operation at 3500m (5000psi).

Item	Quantity	Description
1	10, 20, 50	12 way Fixed ROV Receptacle to 12 way Penetrator, with 3 m PBOF hose. Pins 1-8 connected to Cat5 cable. Pins 9-12 connected to conductors rated for 600V/25A.
2	2, 10, 20	12 way Flying ROV Plug to 12 way Penetrator, with 10 m PBOF hose. Pins 1-8 connected to Cat5 cable. Pins 9-12 connected to conductors rated for 600V/25A
3	2, 10, 20	12 way Flying ROV Plug terminated to customer supplied cable similar to Falmat FMXCAT52218K12 Pins 1-8 connected to Cat5 cable. Pins 9-12 connected to conductors rated for 600V/5A
4	2, 10, 50	Hybrid Fixed ROV Receptacle to Penetrator, with 3 m PBOF hose. 4 single mode optical fibers 2 electrical conductors rated for 600V/25A
5	2, 10, 20	Hybrid Flying ROV Plug to Penetrator, with 10 m PBOF hose. 4 single mode optical fibers 2 electrical conductors rated for 600V/25A
6	2, 10, 20	Hybrid Flying ROV Plug terminated to customer furnished cable, similar to Cortland HV506011 (spec sheet attached). 4 single mode optical fibers 2 electrical conductors rated for 600V/5A

7	2, 5, 10	2 way Fixed ROV Receptacle to 2 way Penetrator, with 3 m PBOF hose. Pins and conductors rated for 10kV/5A.
8	2, 5, 10	2 way Flying ROV Plug to 2 way Penetrator, with 3 m PBOF hose. Pins and conductors rated for 10kV/5A.
9	2, 5, 10	Optical Fixed ROV Receptacle to Penetrator, with 3 m PBOF hose. 4 single mode optical fibers
10	2, 5, 10	Optical Flying ROV Plug to Penetrator, with 10 m PBOF hose. 4 single mode optical fibers

Please provide a cost quotation and delivery time for each of items described above for each of the quantities shown.

Thank you and best regards,

Tim McGinnis
UW/APL

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00002**
For:	ODI Wet Mate Connectors
Type:	Budgetary Quote
Date:	Sept 17, 2008
Company:	ODI
Requested By:	Harrington

Notes:

ODI
A Teledyne Majority Owned Company

- Budgetary Quotation # 13290 -

Ocean Design, Inc. (ODI) is pleased to offer the following quotation:

Date: 17-Sep-08
To: University of Washington - Applied Physics Laboratory
Attn: Mr. Michael Harrington, Mr. Skip Denny
Re: OOI - RSN Project

The following pricing includes Ocean Design's standard Factory Acceptance Testing (FAT) in accordance with our latest FAT procedures.

		3000m		Conn/Assy Qtys		University of Washington	
Item	**No. of Line Items**	**Unit**	**ODI Assembly Part Number (Type Designation)**	**Qty Per Line Item**	**TOTAL QTY**	**Line Item Unit Price**	**Line Item Total Price**
1A	1	**Assembly #1 Consisting Of:-**	**TBD**			$101,590	$101,590
1A.1	1	4SM/2E NRH ROV Cable End Receptacle (Pin Contacts) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1		
1A.2	1	3m x 4SM/2E Fluid Filled Hose Assembly		1	1		
1A.3	1	1 In / 1 Out 4SM/2E Hybrid FACT Assembly - 316SS Shell		1	1		
1A.4	1	20km South Bay SB-46008, CUSTOMER SUPPLIED MATERIAL		1	1		
1A.5	1	3m x 4SM/2E Fluid Filled Hose Assembly		1	1		
1A.6	1	1 In / 1 Out 4SM/2E Hybrid FACT Assembly - 316SS Shell		1	1		
1A.7	1	4SM/2E NRH ROV Cable End Receptacle (Sockets) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1		
1B1	1	**Assembly #1 - PARTS ONLY - Consisting Of:-**	**TBD**			$94,663	$94,663
1B1.1	1	4SM/2E NRH ROV Cable End Receptacle (Pin Contacts) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		2	2		
1B1.2	1	3m Fluid Filled Hose Assembly		2	2		
1B1.3	1	1 In / 1 Out 4SM/2E Hybrid FACT Assembly - 316SS Shell		2	2		
1B2	1	Field Installation In Accordance With Attached Rates		1	1		
2	1	**Assembly #2 Consisting Of:-**	**TBD**			$10,068	$10,068
2.1	1	12-Way ROV Cable End Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1		

2.2	1	50m Fluid Filled Hose Assembly		1	1		
2.3	1	12-Way Bulkhead Penetrator with Straight Integral Hose Termination and 1m Wire Pigtails - Titanium CP, Gr2 Shell		1	1		
3A	1	**Assembly #3 Consisting Of:-**	**TBD**			$34,616	$34,616
3A.1	1	12-Way ROV Cable End Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1		
3A.2	1	3m x 12-Way Fluid Filled Hose Assembly		1	1		
3A.3	1	1 In / 1 Out 12-Way Electrical FACT Assembly - 316SS Shell		1	1		
3A.4	1	50m South Bay SB-46008, CUSTOMER SUPPLIED MATERIAL		1	1		
3A.5	1	1 In / 1 Out 12-Way Electrical FACT Assembly - 316SS Shell		1	1		
3A.6	1	3m x 12-Way Fluid Filled Hose Assembly		1	1		
3A.7	1	12-Way ROV Cable End Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		1	1		
3B	1	**Assembly #3 - PARTS ONLY - Consisting Of:-**	**TBD**			$30,589	$30,589
3B.1	1	12-Way ROV Cable End Plug (Pins) with 90° Integral Hose Termination - Titanium CP, Gr2 Shell		2	2		
3B.2	1	3m x 12-Way Fluid Filled Hose Assembly		2	2		
3B.3	1	1 In / 1 Out 12-Way Electrical FACT Assembly - 316SS Shell		2	2		
3B2	1	Field Installation In Accordance With Attached Rates		1	1		
4	1	**Assembly #4, ODI Mini-Gateway, Consisting Of:-**	**TBD**			$134,627	$134,627
4.1	1	4SM/2E NRH ROV Bulkhead Fixed Plug (Pins) with No Termination & Isolation - Titanium CP, Gr2 Shell		2	2		
4.2	1	12-Way ROV Bulkhead Fixed Receptacle (Sockets) with No Termination & Isolation - Titanium CP, Gr2 Shell		4	4		
4.3	1	Pressure Compensated, Oil-Filled Mini-Gateway Junction Box with Bridge and Integral Fiber Management - 316SS Painted		1	1		
4.5	1	8SM Hybrid DMS Submersible Bulkhead Fixed Plug (Pins) with No Termination & Isolation - Titanium CP, Gr2 Shell		1	1		
4.6	1	16E Hybrid Submersible Bulkhead Fixed Receptacle (Pins) with No Termination - 316SS Shell		3	3		

4.7	1	4E Hybrid Submersible Bulkhead Fixed Receptacle (Pins) with No Termination - 316SS Shell		1	1		
5	1	On Site Assembly and Installation of FACT Components in Accordance with Attached Rate Sheet					

Delivery	General Arrangement Drawings Available within 5 Weeks After Receipt of Order. Product Shipment to commence, in Mutually Agreed Batches, within 16 Weeks After Receipt of Customer Approval of General Arrangement Drawings.
Point of Delivery	Ex-Works, Ocean Design, Inc, Daytona Beach, FL USA
Payment Terms	Discount 1%-10, Net 30 Days From Date of Invoice
Customer Supplied Material	Cable Sample and Spec due with Placement of Order. Customer Supplied Material (CSM) is required 8 weeks prior to delivery. Please note that ODI reserves the right to ship in place, transfer title of goods, and invoice for any items which may be withheld from dispatch pending delivery of CSM and/or authorization.

Price includes Certificate of Conformity. Standard QC documentation is provided in electronic format. Paper copies are subject to an additional charge.

Customer Witness/Third Party Inspection may be subject to an additional delivery time and charges at time of order. Please contact ODI for information.

This Quotation, valid for 30 days, is subject to Ocean Design, Inc. attached Standard Terms and Conditions of Sale - dated 01-Aug-08.

Sincerely,
For Ocean Design, Inc.

Jon A. Rinkenberger, Cost and Pricing Analyst

Ocean Design, Inc. a Teledyne Company
Terms and Conditions of Sale – 01-Aug-08

The Terms and Conditions of sale contained herein, together with any additional terms and conditions set forth in ODI's Order Acknowledgement Form, shall apply to all quotations made, and to all contracts entered into, between Ocean Design, Inc. ("ODI") and Buyer for the sale of any manufactured product, components, spare parts and any Services collectively ("Products").

1. Acceptance of Order. All purchase orders ("Orders") must be approved and accepted in writing by ODI and no term or condition contained in any Order that varies from, or conflicts with, any of these Terms and Conditions shall become part of any contract for the sale of Products unless such term or condition is expressly *accepted in writing* by ODI's authorized representative.

2. Shipping Terms. All shipments are pursuant to Incoterms 2000 ExWorks (ODI's manufacturing point). ODI reserves the right to make partial shipments at its discretion.

3. Termination for Cause. In the event the order is terminated for cause by ODI for Buyer's breach of these terms, ODI shall have no further liability to Buyer and ODI shall not be liable for any costs of cancellation, special, incidental or consequential damages (including punitive or exemplary damages) for any cause or of any nature whatsoever and such cancellation shall be in addition to any other rights and remedies of ODI under this order or at Law. Further, ODI reserves the right to cancel this order or any portion thereof without liability if Buyer fails to make payment as required by the terms of this order or if Buyer is adjudicated bankrupt, files a petition in bankruptcy, makes an assignment for the benefit of creditors or if action under any law for the relief of debtors is taken.

4. Termination for Convenience. Buyer may cancel orders only upon reasonable advance written notice and upon payment to ODI for cancellation charges which include, among other things, all costs and expenses incurred, and to cover commitments made, by ODI and a reasonable profit thereon. ODI's determination of such termination charges shall be conclusive.

5. Payment Terms. Payment of all invoices to Buyer shall be in US Dollars and are due thirty (30) days from the date of invoice. A late charge, of the lesser of 1.5% per month or the maximum amount permitted by law shall be assessed on all overdue payments. Buyer hereby waives any right of setoff against payments due for Products.

6. Raw Material Surcharges. The price for supplies containing precious metals, nonferrous metals, magnetic minerals, and/or alloys thereof shall be subject to application of surcharge(s) at the time of shipment, based upon fluctuations in the market value of such raw materials.

7. Buyer's Obligation of Assistance. Except to the extent ODI has otherwise assumed such responsibility for itself under express provisions of the attachment hereto entitled "Statement of Work" Buyer shall: a) place at ODI's disposal all information necessary for performance of the work including any plans, plant layout, wiring instructions and operational information that may reasonably be expected to affect the performance of the work. This includes to the extent reasonable previous studies or reports and other data relative to the design, installation and selection of equipment for the work to be performed by ODI. b) Buyer guarantees access to and to make all reasonable provisions for ODI to enter on its property and other public and private lands as is required for performance of the work including safe storage of equipment, materials and tools during the process of any such off-site work. c) Buyer agrees to cooperate in all reasonable ways necessary to ODI's performance of the work. d) Buyer covenants that it has disclosed fully and accurately to ODI all general and local conditions that can affect performance of the work prescribed hereunder or the price thereof. Buyer acknowledges that ODI is entitled to rely on information furnished by Buyer in developing its specifications, equipment selection, price and other terms of this order.

8. Limited Warranty. ODI Products shall be warranted for a period of two (2) years from the date of shipment or one (1) year from the date of installation. Services are warranted for ninety (90) days unless otherwise mutually agreed upon under a separate service contract. This warranty shall not apply to any Product that upon examination by ODI is found to have been subject to mishandling, misuse, negligence, tampering, repair or alteration by Buyer without ODI's express prior approval, Product that is improperly stored, installed, operated or maintained in a manner not in accordance with ODI's instructions, or damaged due to an accident. All returns are subject to ODI's then current Return Material Authorization Procedure. The sole remedy of Buyer pursuant to this warranty is to require ODI to repair and/or replace defective components, or if necessary the whole Product for no additional charge. This warranty does not provide for the costs incurred accessing the location of the equipment, dismantling, re-installation or re-commissioning after repair. Neither shall ODI be liable for costs related to any work performed below the waterline or subsea, heavy lift operations nor the transportation to or from offshore locations. **THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

9. RMA Procedure. Buyer shall not return any Product, which Buyer believes to be defective, without a return material authorization number ("RMA") issued by ODI in accordance with its then current RMA procedure. For every Product returned by Buyer subject to this provision Buyer must provide ODI with the Product serial number for verification of warranty coverage enabling ODI to repair or replace the Product without charge. Buyer must issue an Order for Service to ODI in all cases, Buyer shall ship the Product together with the RMA information to the address provided by ODI; and ODI shall repair or replace the returned Product. ODI shall pay shipping costs for Product under warranty or if the Buyer is otherwise entitled to repair/replacement without charge. If it is found that any Product has been returned which is not defective or non-conforming, Buyer will be so notified and such Product will be returned at Buyer's expense. In no event will ODI retain or store the returned Product for more than six (6) months. In addition, a charge for testing and examination may, in ODI's sole discretion, be made on any Product so returned.

10. Proprietary Rights & License. ODI will retain all right, title and interest in and to any data, software programs, tools, specifications, templates, scripts, ideas, concepts, inventions, works of authorship, products, know-how, processes, and techniques used or developed by ODI or its employees or subcontractors in connection with performing and delivering products hereunder. For the Products provided to Buyer pursuant to these Terms and Conditions for which Buyer has paid ODI all amounts owed, ODI hereby grants to Buyer a non-exclusive, royalty-free, perpetual license to use and display such Products solely for its own internal business purposes. Buyer agrees that ODI retains

proprietary rights in and to all Products specifications, designs, engineering details, discoveries, inventions, patents, copyrights, trademarks, trade secrets and other proprietary rights relating to the Products.

11. Export Compliance. Buyer acknowledges that the Products shipped by ODI are subject to the U.S. Commerce and/or State Department Export Regulations under the laws and regulations of the United States and of other countries as applicable. Buyer agrees to comply with all laws and regulations governing the use, export, re-export, and transfer of the ODI Products and the technology embodied therein. Buyer and ODI each agree to provide to the other such information and assistance as may reasonably be required in connection with securing the necessary authorizations or licenses, and to take timely action to obtain any required authorizations or licenses. Buyer agrees to indemnify and hold ODI harmless from any liability arising from the failure of Buyer to comply with all such laws and regulations.

12. Patent Indemnification.
ODI shall indemnify and defend Buyer and its affiliates, officers, directors, and employees, from (or settle at its option and expense) any third-party claims brought against Buyer, to the extent that it is based on a claim that the deliverables provided to Buyer by ODI and used in accordance with any specification provided infringes on any U.S., Canada, Brazil, Japan, Italy, France, UK, or Norway patent, copyright or trade secret, and ODI will pay all damages, fines, penalties, expenses and costs (including reasonable legal fees) incurred by Buyer or paid in settlement or awarded by a court of final appeal attributable to such claim, provided that Buyer notifies ODI in writing of any such claim as soon as reasonably practicable and allows ODI to control, and reasonably cooperates with ODI in the defense of any such claim and related settlement negotiations (subject however, to Buyer's reasonable approval of ODI's decisions). To the extent that any Service or deliverable is held by a court of competent jurisdiction, or is believed by ODI to infringe or otherwise violate a third party proprietary right, ODI may, at its option and expense, do one or more of the following: (i) modify the affected material to be non-infringing; or (ii) obtain for Buyer a license to continue using such material on substantially the terms set forth herein; or, if neither alternative is reasonably available to ODI, (iii) require return of the infringing material and all rights thereto from Buyer and refund to Buyer the fees paid for the infringing material and provide costs of locating replacement material. ODI will have no obligation under this provision to the extent any claim is based on: (i) modifications to the deliverables by a party other than ODI or its authorized representative; (ii) the combination, operation, or use of the Services or deliverables with equipment, devices, software or data not supplied by ODI, or in an environment for which the Services or deliverables were not intended; (iii) Buyer's failure to use updated or modified versions of the deliverables provided by ODI; (iv) ODI's compliance with any designs or specifications provided by Buyer or (v) the negligent acts or willful misconduct of Buyer, or its employees or ODI (each, an "Indemnity Exclusion"). **THE FOREGOING CONSTITUTES THE ENTIRE LIABILITY OF ODI AND BUYER'S SOLE AND EXCLUSIVE REMEDY WITH RESPECT TO ANY CLAIMS OF INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.**

13. General Indemnity. ODI agrees to indemnify Buyer against any claims against Buyer for direct loss, liability or damages in respect to bodily injury or death or loss of or damage to tangible property, but not otherwise, up to the limits of ODI's insurance policy as a result of any negligent act or omission of ODI's employees during any work at Buyer's facilities. ODI's indemnification obligations under this provision shall apply only if Buyer has provided notice to ODI, in writing, of any such claims within ten (10) calendar days after the date on which Buyer first receives any notice, written or oral, that such claims may be asserted against Buyer. Upon receipt of any such written notice from Buyer, ODI or its representative shall have the right to defend any such claims at ODI's expense and/or to participate in any discussion or agreements entered into by Buyer to settle same. ODI shall not be bound by any judgments or settlement agreements to which it has not been a party or to which it has not consented in writing. The above constitutes the full extent of ODI's indemnification obligation, express or implied, to Buyer.

14. LIMITATION OF LIABILITY. **NEITHER ODI NOR BUYER SHALL HAVE ANY LIABILITY TO THE OTHER OR TO ANY THIRD PARTY FOR ANY LOST PROFITS, LOST DATA, LOSS OF USE OR COSTS OF PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, OR FOR ANY INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING IN ANY WAY OUT OF THIS AGREEMENT OR THE USE OF THE PRODUCTS, UNDER ANY CAUSE OF ACTION OR THEORY OF LIABILITY, AND IRRESPECTIVE OF WHETHER SUCH PARTY HAD ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES. NO ACTION ARISING OUT OF ANY CLAIMED BREACH OF THESE TERMS AND CONDITIONS MAY BE BROUGHT BY BUYER MORE THAN ONE YEAR AFTER THE CAUSE OF ACTION HAS OCCURRED.**

15. Insurance. Buyer shall maintain its usual and customary insurance coverage for automobile, workmen's compensation and third party liability claims during performance of the Order(s) and if requested by ODI, name ODI as an additional insured under its third party liability coverage.

16. Assignment. Except as herein expressly provided to the contrary, the sale of Products and Services is solely to Buyer and is not for the benefit of any third party. Any attempted assignment by Buyer of Buyer's purchase agreement or of any rights arising under these Terms and Conditions without the written consent of ODI shall be void and of no effect whatsoever.

17. Force Majeure. Except for the obligation to pay monies due and owing, neither party shall be liable for any delay or failure in performance due to events outside the defaulting party's reasonable control, including without limitation acts of God, earthquake, hurricane, labor disputes, shortages of supplies, actions of governmental entities, riots, war, fire, epidemics, terrorism, or delays of common carriers or other circumstances beyond its reasonable control. The obligations and rights of the excused party shall be extended on a day to day basis for the time period equal to the period of the excusable delay, or if appropriate, this order or any part thereof may be cancelled upon the mutual agreement of the parties.

18. Entirety; Modification, Amendment, Supplement and Waiver: these Terms and Conditions constitute the entire agreement between the parties and supersedes all previous agreements, promises, proposals, representations, understandings and negotiations, whether written or oral, between the parties pertaining to the subject matter hereof. These terms and applicable statement(s) of work shall prevail over all preprinted forms, including purchase orders, and invoices, as any terms and conditions on such preprinted forms shall be null and void unless otherwise agreed to in writing by both parties. No modification, amendment, supplement to or waiver of this Terms and Conditions, or any provisions hereof or thereof shall be binding upon the parties unless made in writing and duly signed by both parties; provided, for the avoidance of doubt, no modification, amendment, supplement to or waiver of this Terms and Conditions, or provision hereof or thereof, shall be made via electronic communication unless the parties first agree in writing (that is not an electronic communication) to be bound by electronic communications. At no time shall any failure or delay by either party in enforcing any provisions, exercising any option, or requiring performance of any provisions, be construed to be a waiver of same.

19. Governing Law. The validity, interpretation, and performance shall be controlled by and construed under the laws of the State of California, United States of America, as if performed wholly within the state and without giving effect to the principles of conflicts of law, and the State and federal courts of California shall have jurisdiction over any claim arising hereunder. The parties specifically disclaim the UN Convention on Contracts for the International Sale of Goods. Notwithstanding the foregoing, either party may seek interim injunctive relief in any court of appropriate jurisdiction with respect to any alleged breach of such party's proprietary rights.

20. Notices. Unless otherwise specified, all notices shall be in writing and delivered personally or mailed, first class mail, postage prepaid, to the addresses of the parties set forth on the applicable Order. If to ODI: Attn: Contracts Department, 1026 N. Williamson Blvd., Daytona Beach, FL 32114 USA. Either party may change the address (es) or addressee(s) for notice hereunder upon written notice to the other. All notices shall be deemed given on the date delivered.

*****

ODI A Teledyne Majority Owned Company

Attachment 1 – Field Service Rates
Effective from 01-Jan-2008 to 31-Dec-2008

ONSHORE

DAY RATE:	Electrical Technician	– $ 870 per	(8 hour day or part of)
	Optical Technician	– $1,040 per	(8 hour day or part of)
	Engineer	– $1,320 per	(8 hour day or part of)

OFFSHORE

DAY RATE:	Electrical Technician	– $1,790 per	(12 hour day or part of)
	Optical Technician	– $1,960 per	(12 hour day or part of)
	Engineer	– $2,260 per	(12 hour day or part of)

TRAVEL: Per ONSHORE DAY RATE at 8 hours per travel day.

EXPENSES: ACTUAL COST – **Plus 15% –** of:

Air Fare, Rental Car, Hotel

Mileage & Per Diem – Not to exceed IRS Guidelines for Mileage, Meals & Incidental Expenses(M&IE)

All costs associated with the transportation of tools, test equipment, etc to/from the worksite

OTHER CHARGES: Any parts not covered by Warranty

DOCUMENTATION: A Field Service Daily Report, endorsed by the Client, will be provided with each Service Call. It will include time and materials used.

EMERGENCY CALLOUT PREMIUM (LESS THAN 72 HOURS NOTICE): – $500
(Must have P.O. in place at time of mobilization)

NOTES: Hours in excess of 8 per day onshore (12 per day offshore) are charged on a pro-rata basis.

Late changes to mobilizations – less than 72 hours prior to departure – will be subject to a rescheduling fee.

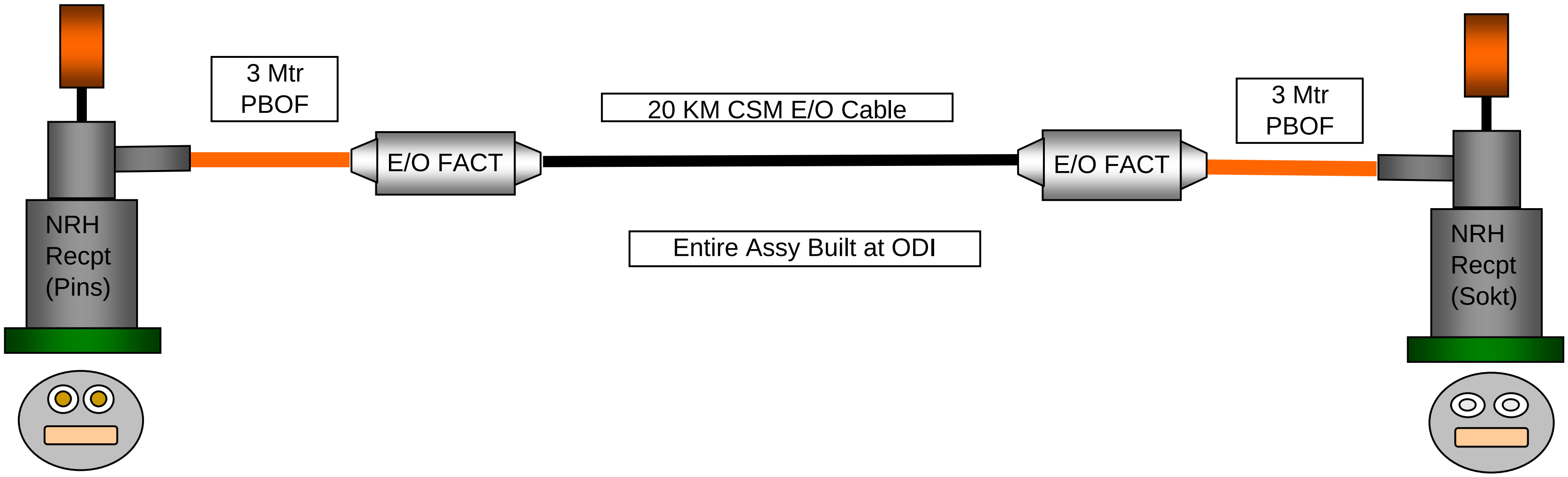
Additional charges may be applicable for mobilizations to countries that are subject to U.S. Department of State travel advisories.

ODI reserves the right to rotate field service personnel, at Client’s expense, after 28 days on location.

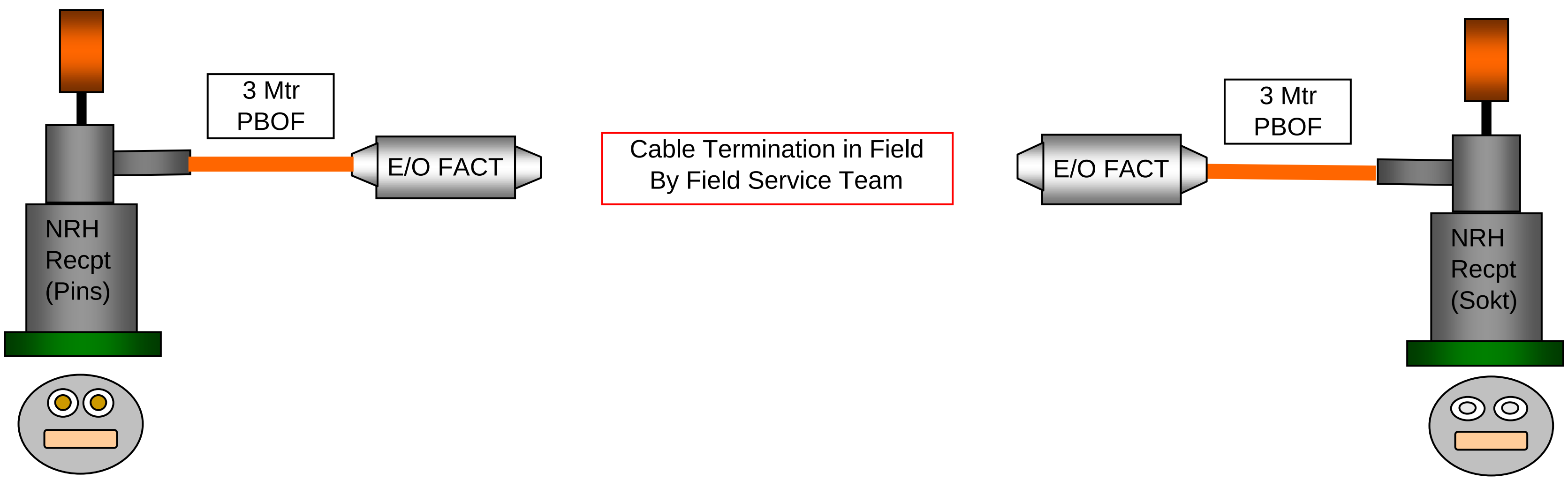
For continuous mobilizations in excess of 2 weeks, ODI reserves the right to invoice time and materials plus expenses, as incurred, for each two week period.

ODI Budgetary Quote # 13290 9/17/08

1A

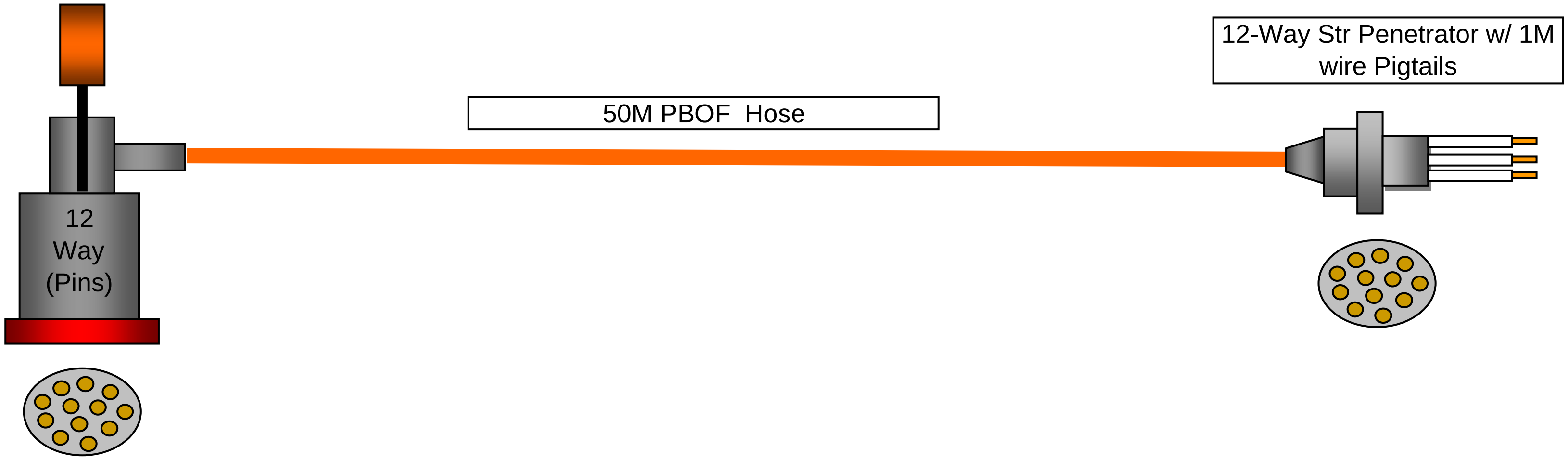


1B

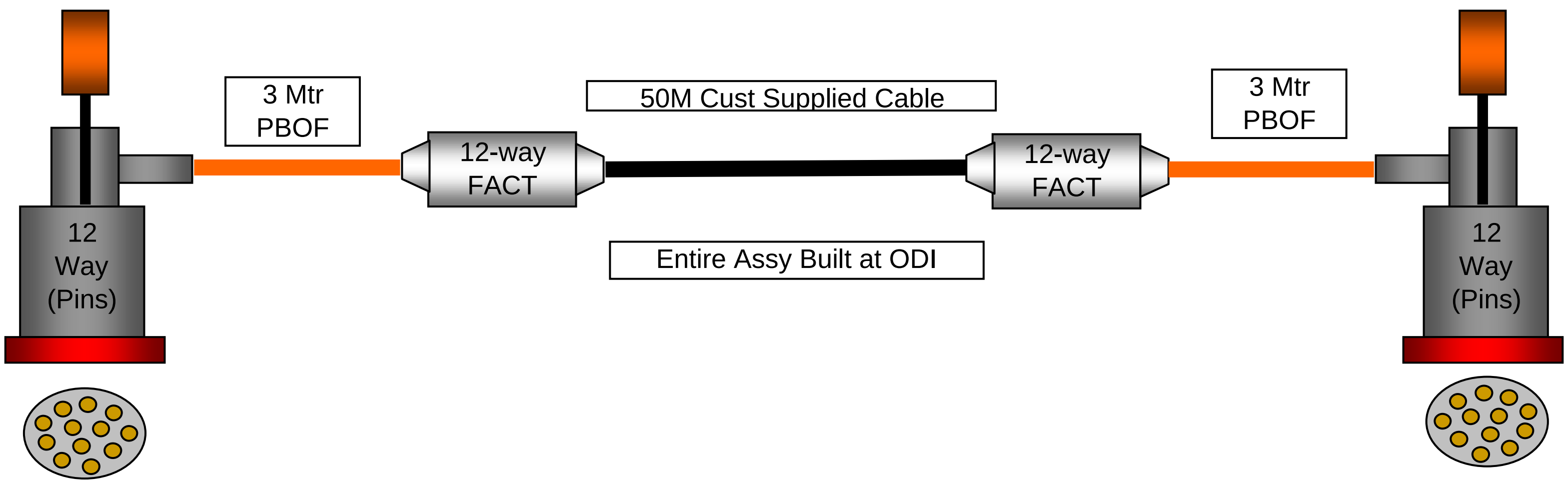


ODI Budgetary Quote # 13290 9/17/08

2



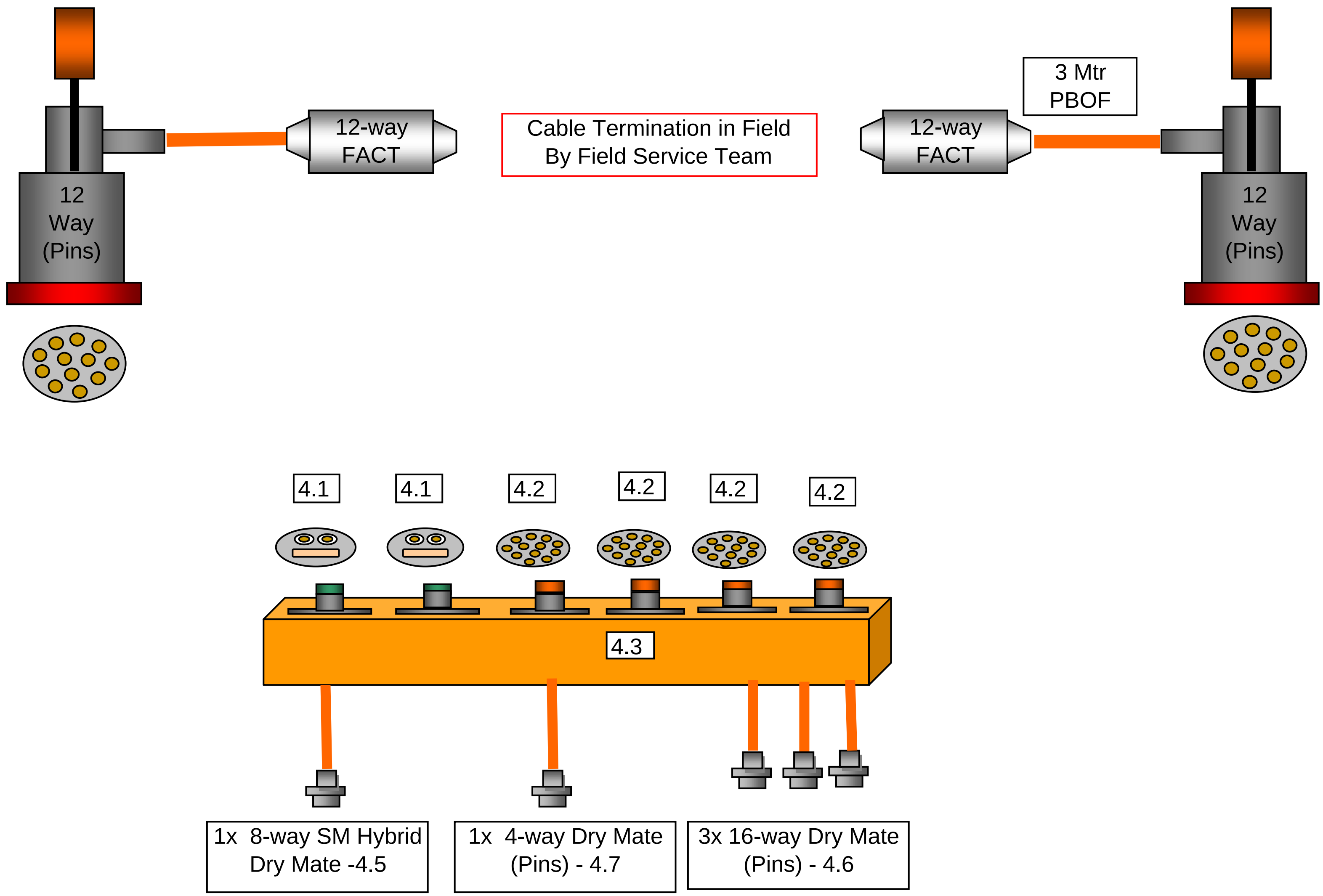
3A



ODI Budgetary Quote # 13290 9/17/08

3B

4



Request for Budgetary Pricing Information for ODI ROV Wet Mateable Connectors Assemblies.

Mike Harrington
Applied Physics Laboratory
for the OOI – RSN Project

8/19/2008

John Flynn,
Ocean Design Inc,

Dear Mr. Flynn,

Thanks taking the time to talk with us about our project this week. As we discussed would you please provide budgetary pricing information for the following configurations as show in the accompanying diagram? Please let me know if you need further clarification to make an appropriate estimate.

Sincerely,
Mike

Assembly #1. This is an assembly for a 20 km Electrical Optical Cable with NRH Connectors with two high power pins and 4 fiber optic pins on both sides with a CTA to convert it to the EOM cable like the attached cable drawing.

Please price assuming we supply the cable, but you would make the connections (either sending a technician here to do it or shipping the cable back and forth), include the two connectors, CTA, assembly charges and standard testing.

Assembly #2. This is an assembly for a 50 meter oil filled hose with Nautilus Standard Wet-Mate Electrical Connectors with 12 pins on one side with and a penetrator on the other.

Please price assuming you supply the hose.

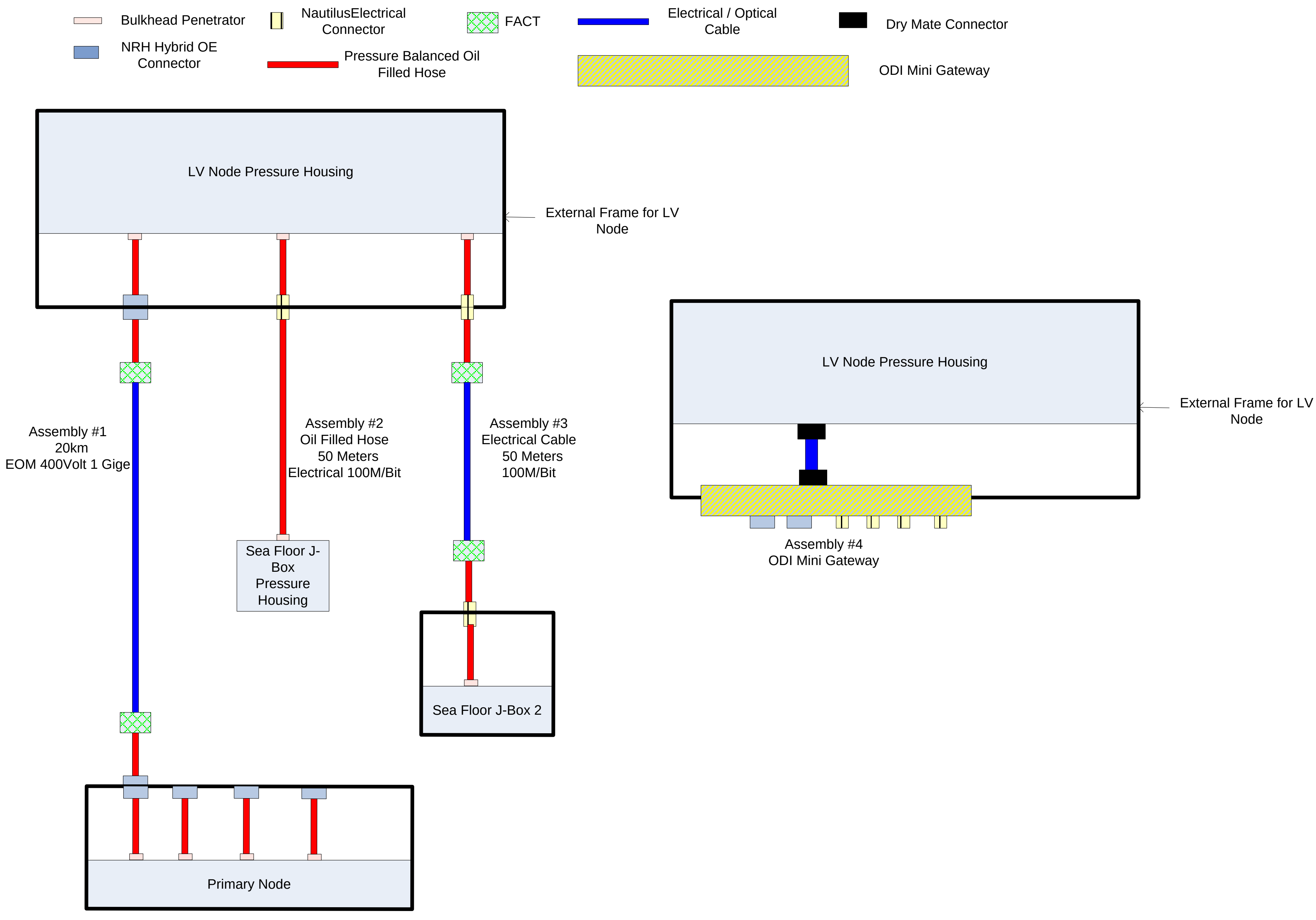
Assembly #3 This is an assembly for a 50 m Electrical Optical Cable with Nautilus Standard Wet-Mate Electrical Connectors with 12 pins on one side with on both sides with a CTA to convert it to the Electrical cable.

Please price assuming we supply the cable, but you would make the connections (either sending a technician here to do it or shipping the cable back and forth), include the two connectors, CTA, assembly charges and standard testing.

Assembly #4 ODI Mini-Gateway for depth up to 3000 m with 2 NRH connectors, Nautilus Standard Wet-Mate Electrical Connectors and with a Dry-Mate Connector.

You do not need to price the connectors (Dry or Wet mate) but include assembly and test charges about the standard rate for those connectors.

RSN Connector Layout



Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00003**
For:	Secondary Cables
Type:	Budgetary Quote
Date:	July 12, 2007
Company:	South Bay Cable Corp.
Requested By:	Harrington

Notes:

South Bay Cable Corp.

South Bay Cable

P.O. Box 67 • Idyllwild, California 92549 • (951) 659-2183 • FAX (951) 659-3958
www.southbaycable.com

University of Washington / APL
Seattle, WA

Attn: Mike Harrington

QUOTATION IN RESPONSE TO RFQ Verbal

OUR QUOTATION No. 76727

AGENT No Agent

DATE July 12, 2007

WE ARE PLEASED TO OFFER OUR QUOTATION IN REPLY TO YOUR REQUEST ABOVE AS FOLLOWS:

1a	100 Mtrs. (1 X)	High Power RSN Mooring System Riser Cable Per SB-46007	$167.45/Mtr.
1b	2,000 Mtrs. (1 X)	High Power RSN Mooring System Riser Cable Per SB-46007	$56.80/Mtr.
2a	100 Mtrs. (1 X)	High Power RSN Sea Floor Cable Per SB-46008	$98.75/Mtr.
2b	5,000 Mtrs. (1 X)	High Power RSN Sea Floor Cable Per SB-46008	$25.40/Mtr.
3a	100 Mtrs. (1 X)	Low Power RSN Mooring System Riser Cable Per SB-46009	$159.25/Mtr.
3b	2,000 Mtrs. (1 X)	Low Power RSN Mooring System Riser Cable Per SB-46009	$51.50/Mtr.
4a	100 Mtrs. (1 X)	Low Power RSN Sea Floor Cable Per SB-46010	$89.55/Mtr.
4b	5,000 Mtrs. (1 X)	Low Power RSN Sea Floor Cable Per SB-46010	$19.95/Mtr.
		OVERSHIPMENT WILL BE BILLED AT THE UNIT PRICE	

FOB: IDYLLWILD ☒ **OTHER** ______ **REELS: NO CHARGE** ☒ **OTHER** ______
FIRM FOR: 30 DAYS ☒ **OTHER** ______
TERMS: NET 30 ☒ **OTHER** * **TOLERANCE ON QTY. + 10%-0%** ☐ **OTHER** +/-0%
SHIPPING ESTIMATE: 12-14 Weeks

*Terms subject to credit approval

FOR SOUTH BAY CABLE CORP.

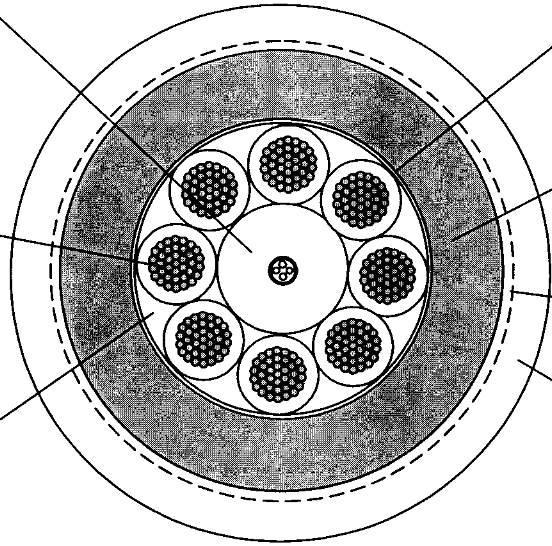
Bill Tell, Sales Engineer

REVISION			
	DESCRIPTION	DATE	APPROVAL

FIBER OPTICS-4 UNITS
4 # Single-mode F/O's (SMF-28)
in a gel-filled stainless steel tube
Fibers are color coded
Polyethylene Jacket (Black)

SINGLE CONDUCTORS-8 UNITS
Awg No. 11(37 x 0.0142") B/C
DC Resistance @ 20° C ≤ 1.72 Ohms/1000 Ft
Polypropylene Insulation
Voltage Rating: 600 V
Color Code: 4 White
4 Black

INTERSTICES WATERBLOCKED



TAPE
Mylar Tape

STRENGTH MEMBER
Layers of Vectran™
Mylar Tape over each layer

REINFORCEMENT BRAID
Dacron Braid

JACKET
Polyurethane
Color: Orange

ESTIMATED VALUES

Nominal O.D.----------------------	0.980"
Weight in Air---------------------	550 Lb/1,000 Feet
Weight in Seawater---------------	215 Lb/1,000 Feet
Breaking Strength-----------------	30,000 Pounds (min.)
Maximum Load-------------------	6,000 Pounds
Min. Bend Diameter--------------	32 Inches

South Bay Cable

S
B
C

Drawn	L.L.	7/11/07	Approval		
Checked	O.L.	7/11/07	Approval		

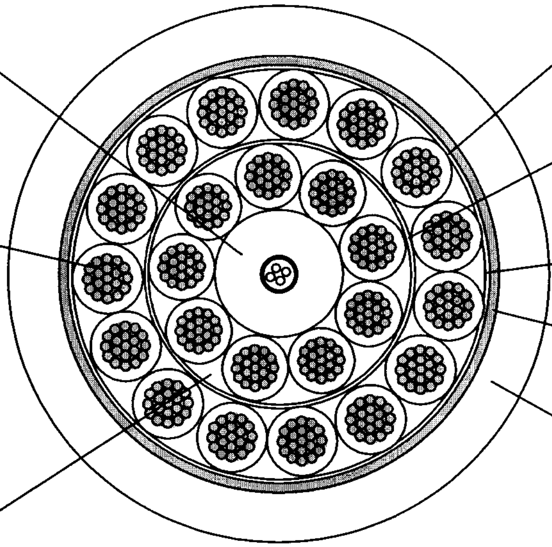
E-O-M Cable | **SB-46007**

REVISION			
	DESCRIPTION	DATE	APPROVAL

FIBER OPTICS-4 UNITS
4 # Single Mode (SMF-28) F/O's
in a gel-filled stainless steel tube
Fibers are color coded
Polyethylene Jacket (Black)

SINGLE CONDUCTORS-24 UNITS
Awg No. 16(19 x 0.0113") B/C (Interstices Waterblocked)
DC Resistance @ 20° C $\leq$ 5.25 Ohms/1000 Ft
Polypropylene Insulation
Voltage Rating: 600 V
Color Code: 12 White
12 Black

INTERSTICES WATERBLOCKED



TAPE
Mylar Tape

TAPE
Mylar Tape

INTERSTICES WATERBLOCKED

STRENGTH MEMBER
Kevlar™ Braid

JACKET
Polyurethane
Color: Orange

ESTIMATED VALUES

Nominal O.D.----------------------	0.650"
Weight in Air----------------------	335 Lb/1,000 Feet
Weight in Seawater--------------	190 Lb/1,000 Feet
Breaking Strength----------------	1,500 Pounds (min.)
Maximum Load-------------------	300 Pounds
Min. Bend Diameter-------------	18 Inches

South Bay Cable S B C

Drawn	L.L.	7/11/07	Approval		
Checked	O.L.	7/11/07	Approval		

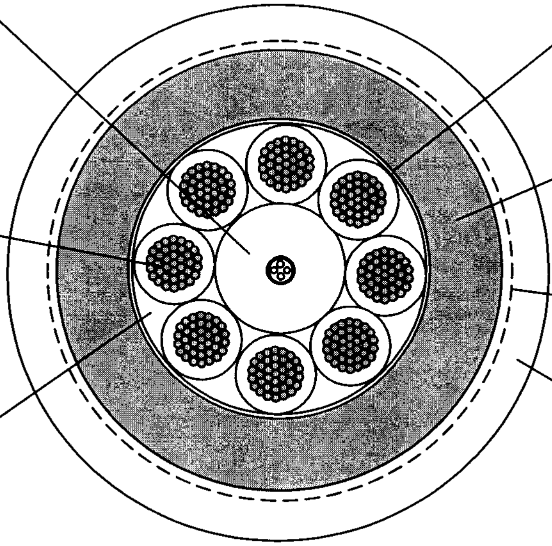
E-O-M Cable **SB-46008**

REVISION			
	DESCRIPTION	DATE	APPROVAL

FIBER OPTICS-4 UNITS
4 # Single-mode F/O's (SMF-28)
in a gel-filled stainless steel tube
Fibers are color coded
Polyethylene Jacket (Black)

SINGLE CONDUCTORS-8 UNITS
Awg No. 14(37 x 0.0113") B/C (Interstices Waterblocked)
DC Resistance @ 20° C ≤ 2.72 Ohms/1000 Ft
Polypropylene Insulation
Voltage Rating: 600 V
Color Code: 4 White
4 Black

INTERSTICES WATERBLOCKED



TAPE
Mylar Tape

STRENGTH MEMBER
Layers of Vectran™
Mylar Tape over each layer

REINFORCEMENT BRAID
Dacron Braid

JACKET
Polyurethane
Color: Orange

ESTIMATED VALUES

Nominal O.D.----------------------	**0.930"**
Weight in Air----------------------	**450 Lb/1,000 Feet**
Weight in Seawater---------------	**150 Lb/1,000 Feet**
Breaking Strength----------------	**30,000 Pounds (min.)**
Maximum Load-------------------	**6,000 Pounds**
Min. Bend Diameter-------------	**30 Inches**

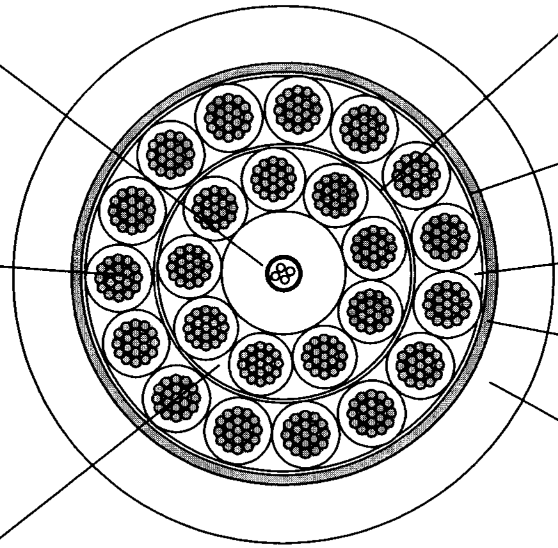
South Bay Cable

S B C

Drawn	L.L.	7/11/07	Approval		
Checked	O.L.	7/11/07	Approval		

E-O-M Cable | **SB-46009**

REVISION			
	DESCRIPTION	DATE	APPROVAL



ESTIMATED VALUES

Nominal O.D.----------------------	**0.590"**
Weight in Air----------------------	**240 Lb/1,000 Feet**
Weight in Seawater---------------	**120 Lb/1,000 Feet**
Breaking Strength-----------------	**1,500 Pounds (min.)**
Maximum Load--------------------	**300 Pounds**
Min. Bend Diameter--------------	**16 Inches**

South Bay Cable

S B C

Drawn	L.L.	7/11/07	Approval		
Checked	O.L.	7/11/07	Approval		

E-O-M Cable | **SB-46010**

HIGH POWER RSN SEAFLOOR CABLE SPECIFICATION

Version 1.0

1.0 INTRODUCTION

The University of Washington Applied Physics Lab (APL) is currently developing a seafloor observatory. The depth of the observatory is planned to be 3000 meters deep in seawater. The observatory design includes electro-optical cable to connect nodes in the system on the seafloor referred to as the **Seafloor Cable**.

2.0 CABLE PROPOSAL REQUIREMENTS.

Prospective vendors are invited to submit proposed cable designs and should include the following information:

2.1 Design and estimated performance documentation.
2.2 Description of the cable construction materials, approximate sectional dimensions and illustration for both fishbite protected and non-protected cable cross-sections (see fishbite protection section below).
2.3 Cable weight per meter in air and seawater.
2.4 Estimated axial stiffness of the cable (EA). Load vs. strain curve should also be included.
2.5 Estimated strain induced rotation of the proposed cable design.
2.6 Cable cost.
2.7 Cable delivery time ARO.
2.8 Availability, cost, and delivery time for sample sections (~50-100 meters) of the proposed design.

3.0 CABLE CONSTRUCTION REQUIREMENTS.

3.1 **Length.** Cable shall be delivered in a continuous length of **5000 meters**. A minimum of five meters shall be accessible at both ends of the cable to allow for testing on the shipping drum. The design should not limit the ability of the vendor to make a 15000 meter length at a later date.
3.2 **Strength member.** The cable strength member shall be synthetic fiber consistent with a minimum seawater weight and good fatigue life over the service life.
3.3 **Jackets.** All sections of the cable shall be jacketed with a non-conductive polymer jacket. The outer jacket color shall be high visibility ORANGE. The jacket shall be free of any skips or gaps that would expose the armor to seawater.
3.4 **Jacket Markings.** The jacket shall be marked with meter markers at least every 5 meters, starting at zero from the buoy end.

4.0 CABLE PERFORMANCE REQUIREMENTS.

4.1 **General and Environmental.** The riser cable performance shall not be degraded by conditions typical of the working environment, including:

4.1.1 Continuous submergence in seawater over working life.
4.1.2 Temperatures from 0 to 25 degrees Centigrade.
4.1.3 Hydrostatic pressure equivalent to 4000 meters seawater (6000 psi).
4.1.4 Service Life. The Seafloor cables shall provide a minimum of 25 years of service while continuously submerged in an ocean environment (see section 2.0).

4.2 Mechanical

4.2.1 Diameter and weight (minimize) In general, the cable diameter and weight affect the rest of the system and should be minimized. However, the highest priority is weight in water and resistance to damage from bending. If improvements in either of these can be achieved at the expense of a slightly larger cable, then this is to be preferred.
4.2.2 Working Strength 300 lbs.
4.2.3 Breaking Strength 1500 lbs. minimum.
4.2.4 Elongation. The strain on the optical package in the cable is not to exceed 0.65% at 6000lbs. load including initial constructional stretch.
4.2.5 Minimum Bend Radius. TBD. Needs to be storable and deployable from a drum.
4.2.6 Fatigue Life. The cable materials and construction shall be suitable for the dynamic loading of continuous operation as a buoy mooring cable. Section 2.0 describes the expected cyclic bending and loading conditions in detail.
4.2.7 Packaging. Standard cable reel suitable for shipping.

4.3 Optical

4.3.1 Fiber Count. There shall nominally be **four** single-mode optical fibers. Fibers shall be Corning “SMF 28” or other suitable fiber selected by cable vendor. Use of alternate fiber shall be by written agreement between vendor and APL. The optical specifications must be met over the specified cable service life during continuous operation under the conditions described in the “General and Environmental” and the “Mechanical” sections above.
4.3.2 Optical Attenuation. Attenuation in each fiber shall not exceed the following values under cable working conditions (see mechanical specifications for working condition values):
0.17 dB per kilometer at 1310 Nm. wavelength
0.17 dB per kilometer at 1550 Nm. Wavelength
4.3.3 Optical Attenuation Uniformity. No single point attenuation discontinuity in any fiber in the finished cable shall be greater than 0.15 dB at either 1310 Nm. or 1550nm. wavelengths, as measured with an OTDR.
4.3.4 Optical Dispersion. Individual fiber specifications for optical dispersion in the completed cable shall meet the pre-cabled fiber manufacturer’s specifications for the fiber used, as measured by EIA/TIA 455-175.
4.3.5 Fiber Proof Test. Individual fibers will be proof tested at the time of manufacture to a minimum of 150kpsi.
4.3.6 Fiber Identification. Fibers or their over-jacketing shall be color coded or otherwise indelibly marked at least every meter for identification

4.4 Electrical

4.4.1 General. The cable will be used for electrical power transmission while submerged in the marine environment. The cable shall provide a minimum of two electrical conductors insulated from one another, and from seawater.

4.4.2 Working Voltage. The cable will be used at a working voltage between conductors, or between conductors and seawater, of up to 425 Volts DC. At this voltage, the maximum electrical stress present at any point in the cable insulation system shall be less than or equal to 2.0 kV/mm (51 volts/mil). The insulation system used must be suitable for continuous high D.C. electric field stress.

4.4.3 Insulation Resistance. The Insulation Resistance of each conductor in the asbuilt cable shall be a minimum of 3,000 Megohms per kilometer, measured at the working voltage of Section 5.4.1 above. The resistance shall be measured between the test conductor, and the other conductor(s) plus the cable armor plus any other metallic cable elements, tied together.

4.4.4 Conductor Resistance. The cable will be used at a working current of up to five ampere per conductor. The maximum as-built, as-cabled, round trip (two way) resistance of the two cable conductors in series shall be a maximum of 3.0 ohms per kilometer (nominally 1.5 ohms per kilometer per conductor, although equal resistances are not required), measured at a conductor temperature of 20 degrees C. The as-built conductor resistance shall have a tolerance of +/- 5%.

4.4.5 Production Testing. Each individually insulated conductor shall be tested for insulation resistance, before cable assembly, in a water bath. The test conditions and criteria for acceptance shall be as specified in Section 5.4.2 above. The completed cable shall be evaluated for Partial Discharge at the working voltage of Section 5.4.1 above. No detectable discharge is permitted, within the detection limits of the test equipment employed.

4.4.6 Conductor Identification. The individual conductors shall be color coded or otherwise made visually distinguishable from one another, either throughout their length, or at regular increments not to exceed 0.33 meter.

5.0 CABLE QUALIFICATION TESTS.

The cable manufacturer shall perform the following test at manufacturer expense and forward the results to APL prior to final acceptance by APL of the completed cable.

The following tests will be performed by APL or an independent test contractor at APL expense prior to final acceptance of the cable. Failure to meet the specified Cable Performance Requirements in section 4.0 is cause to reject the cable.

5.1 **Electrical.** A riser cable specimen will be subjected to conductor resistance and insulation resistance tests to obtain the as delivered values.

5.2 **Optical Static Attenuation.** The riser cable will be tested for optical attenuation at 1310Nm and 1550Nm wavelengths to obtain the as delivered values.

5.3 **Optical Characterization.** The optical attenuation in response to tensile loading will be measured.

5.4 **Mechanical Characterization.** A riser cable section will be tested for tension induced changes in elongation, diameter, torque and rotation. The riser cable will also be tested for yield and breaking strength, and for susceptibility to damage by repeated bending as described in Section 2.0.

6.0 DELIVERY.

Delivery shall be quoted FOB destination, Seattle, WA, 98105. Cable shall be delivered suitably packaged for transportation and storage. Cable shall be delivered in a continuous length. The anchor end of the cable (the end without the fish-bite braid) shall on the outside of the shipping drum and a minimum of five meters shall be accessible at both ends of the cable to allow testing on the shipping drum.

HIGH POWER RSN MOORING SYSTEM RISER CABLE SPECIFICATION

Version 1.0

1.0 INTRODUCTION

The University of Washington Applied Physics Lab (APL) is currently developing a mooring for seafloor observatories. The depth of the observatory is planned to be 3000 meters deep in seawater. The observatory design includes an electro-optical mooring cable referred to as the **Riser Cable**.

2.0 CABLE PROPOSAL REQUIREMENTS.

Prospective vendors are invited to submit proposed cable designs and should include the following information:

2.1 Design and estimated performance documentation.
2.2 Description of the cable construction materials, approximate sectional dimensions and illustration for both fishbite protected and non-protected cable cross-sections (see fishbite protection section below).
2.3 Cable weight per meter in air and seawater for both fishbite protected and non-protected cable cross-sections.
2.4 Estimated axial stiffness of the cable (EA) seawater for both fishbite protected and non-protected cable cross-sections. Load vs. strain curve should also be included.
2.5 Estimated strain induced rotation of the proposed cable design.
2.6 Cable cost.
2.7 Cable delivery time ARO.
2.8 Availability, cost, and delivery time for sample sections (~50-100 meters) of the proposed design.

3.0 CABLE CONSTRUCTION REQUIREMENTS.

3.1 **Length.** Cable shall be delivered in a continuous length of **2000 meters**. A minimum of five meters shall be accessible at both ends of the cable to allow for testing on the shipping drum. Because the overall system is being designed for 4000 meter water depths, the design should not limit the ability of the vendor to make a 5000 meter length at a later date.

3.2 **Strength member.** The cable strength member shall be synthetic fiber consistent with a minimum seawater weight and good fatigue life over the service life.

3.3 **Jackets.** All sections of the cable shall be jacketed with a non-conductive polymer jacket to protection and to allow the operation of inductively coupled data modems on the riser cable. The outer jacket color shall be high visibility ORANGE. The jacket shall be free of any skips or gaps that would expose the armor to seawater.

3.4 **Jacket Markings.** The jacket shall be marked with meter markers at least every 5 meters, starting at zero from the buoy end.

4.0 CABLE PERFORMANCE REQUIREMENTS.

4.1 **General and Environmental.** The riser cable performance shall not be degraded by conditions typical of the working environment, including:

4.1.1 Continuous submergence in seawater over working life.

4.1.2 Temperatures from 0 to 25 degrees Centigrade.

4.1.3 Hydrostatic pressure equivalent to 4000 meters seawater (6000 psi).

4.1.4 Service Life. The Riser cable shall provide a minimum of 25 years of service while continuously submerged in a dynamic ocean environment (see section 2.0).

4.2 Mechanical

4.2.1 Diameter and weight (minimize) In general, the cable diameter and weight affect the rest of the system and should be minimized. However, the highest priority is weight in water and resistance to damage from bending. If improvements in either of these can be achieved at the expense of a slightly larger cable, then this is to be preferred.

4.2.2 Working Strength 6000 lbs.

4.2.3 Breaking Strength 30000 lbs. minimum.

4.2.4 Elongation. The strain on the optical package in the cable is not to exceed 0.65% at 6000lbs. load including initial constructional stretch.

4.2.5 Rotation. The mooring design does not include a swivel, therefore it is important that the cable be torque balanced as much as possible and strain induced rotation shall be minimal in keeping with good design practice.

4.2.6 Minimum Bend Radius. TBD. Needs to be storable and deployable from a drum.

4.2.7 Fatigue Life. The cable materials and construction shall be suitable for the dynamic loading of continuous operation as a buoy mooring cable. Section 2.0 describes the expected cyclic bending and loading conditions in detail.

4.2.8 Packaging. Standard cable reel suitable for shipping.

4.3 Optical

4.3.1 Fiber Count. There shall nominally be **four** single-mode optical fibers. Fibers shall be Corning “SMF 28” or other suitable fiber selected by cable vendor. Use of alternate fiber shall be by written agreement between vendor and APL. The optical specifications must be met over the specified cable service life during continuous operation under the conditions described in the “General and Environmental” and the “Mechanical” sections above.

4.3.2 Optical Attenuation. Attenuation in each fiber shall not exceed the following values under cable working conditions (see mechanical specifications for working condition values):

0.17 dB per kilometer at 1310 Nm. wavelength

0.17 dB per kilometer at 1550 Nm. Wavelength

4.3.3 Optical Attenuation Uniformity. No single point attenuation discontinuity in any fiber in the finished cable shall be greater than 0.15 dB at either 1310 Nm. or 1550nm. wavelengths, as measured with an OTDR.

4.3.4 Optical Dispersion. Individual fiber specifications for optical dispersion in the completed cable shall meet the pre-cabled fiber manufacturer's specifications for the fiber used, as measured by EIA/TIA 455-175.

4.3.5 Fiber Proof Test. Individual fibers will be proof tested at the time of manufacture to a minimum of 150kpsi.

4.3.6 Fiber Identification. Fibers or their over-jacketing shall be color coded or otherwise indelibly marked at least every meter for identification

4.4 Electrical

4.4.1 General. The cable will be used for electrical power transmission while submerged in the marine environment. The cable shall provide a minimum of two electrical conductors insulated from one another, and from seawater.

4.4.2 Working Voltage. The cable will be used at a working voltage between conductors, or between conductors and seawater, of up to 425 Volts DC. At this voltage, the maximum electrical stress present at any point in the cable insulation system shall be less than or equal to 2.0 kV/mm (51 volts/mil). The insulation system used must be suitable for continuous high D.C. electric field stress.

4.4.3 Insulation Resistance. The Insulation Resistance of each conductor in the asbuilt cable shall be a minimum of 3,000 Megohms per kilometer, measured at the working voltage of Section 5.4.1 above. The resistance shall be measured between the test conductor, and the other conductor(s) plus the cable armor plus any other metallic cable elements, tied together.

4.4.4 Conductor Resistance. The cable will be used at a working current of up to five ampere per conductor. The maximum as-built, as-cabled, round trip (two way) resistance of the two cable conductors in series shall be a maximum of 3.0 ohms per kilometer (nominally 1.5 ohms per kilometer per conductor, although equal resistances are not required), measured at a conductor temperature of 20 degrees C. The as-built conductor resistance shall have a tolerance of +/- 5%.

4.4.5 Production Testing. Each individually insulated conductor shall be tested for insulation resistance, before cable assembly, in a water bath. The test conditions and criteria for acceptance shall be as specified in Section 5.4.2 above. The completed cable shall be evaluated for Partial Discharge at the working voltage of Section 5.4.1 above. No detectable discharge is permitted, within the detection limits of the test equipment employed.

4.4.6 Conductor Identification. The individual conductors shall be color coded or otherwise made visually distinguishable from one another, either throughout their length, or at regular increments not to exceed 0.33 meter.

5.0 CABLE QUALIFICATION TESTS.

The cable manufacturer shall perform the following test at manufacturer expense and forward the results to APL prior to final acceptance by APL of the completed cable.

5.1 **Strain on the optical package** at 6000lbs. cable tension. The cable shall be tensioned to 6000 lbs. and the elongation of the optical package measured over ten cycles from 0 to 6000lbs. The total elongation due to initial constructional stretch and load strain on the cable shall not exceed 0.65% on the first through the tenth load cycle. Failure to meet this requirement is cause to reject the cable.

The following tests will be performed by APL or an independent test contractor at APL expense prior to final acceptance of the cable. Failure to meet the specified Cable Performance Requirements in section 4.0 is cause to reject the cable.

5.2 **Electrical.** A riser cable specimen will be subjected to conductor resistance and insulation resistance tests to obtain the as delivered values.

5.3 **Optical Static Attenuation.** The riser cable will be tested for optical attenuation at 1310Nm and 1550Nm wavelengths to obtain the as delivered values.

5.4 **Optical Characterization.** The optical attenuation in response to tensile loading will be measured.

5.5 **Mechanical Characterization.** A riser cable section will be tested for tension induced changes in elongation, diameter, torque and rotation. The riser cable will also be tested for yield and breaking strength, and for susceptibility to damage by repeated bending as described in Section 2.0.

6.0 DELIVERY.

Delivery shall be quoted FOB destination, Seattle, WA, 98105. Cable shall be delivered suitably packaged for transportation and storage. Cable shall be delivered in a continuous length. The anchor end of the cable (the end without the fish-bite braid) shall on the outside of the shipping drum and a minimum of five meters shall be accessible at both ends of the cable to allow testing on the shipping drum.

LOW POWER RSN MOORING SYSTEM RISER CABLE SPECIFICATION

Version 1.0

1.0 INTRODUCTION

The University of Washington Applied Physics Lab (APL) is currently developing a mooring for seafloor observatories. The depth of the observatory is planned to be 3000 meters deep in seawater. The observatory design includes an electro-optical mooring cable referred to as the **Riser Cable**.

2.0 CABLE PROPOSAL REQUIREMENTS.

Prospective vendors are invited to submit proposed cable designs and should include the following information:

2.1 Design and estimated performance documentation.
2.2 Description of the cable construction materials, approximate sectional dimensions and illustration for both fishbite protected and non-protected cable cross-sections (see fishbite protection section below).
2.3 Cable weight per meter in air and seawater for both fishbite protected and non-protected cable cross-sections.
2.4 Estimated axial stiffness of the cable (EA) seawater for both fishbite protected and non-protected cable cross-sections. Load vs. strain curve should also be included.
2.5 Estimated strain induced rotation of the proposed cable design.
2.6 Cable cost.
2.7 Cable delivery time ARO.
2.8 Availability, cost, and delivery time for sample sections (~50-100 meters) of the proposed design.

3.0 CABLE CONSTRUCTION REQUIREMENTS.

3.1 **Length.** Cable shall be delivered in a continuous length of **2000 meters**. A minimum of five meters shall be accessible at both ends of the cable to allow for testing on the shipping drum. Because the overall system is being designed for 4000 meter water depths, the design should not limit the ability of the vendor to make a 5000 meter length at a later date.

3.2 **Strength member.** The cable strength member shall be synthetic fiber consistent with a minimum seawater weight and good fatigue life over the service life.

3.3 **Jackets.** All sections of the cable shall be jacketed with a non-conductive polymer jacket to protection and to allow the operation of inductively coupled data modems on the riser cable. The outer jacket color shall be high visibility ORANGE. The jacket shall be free of any skips or gaps that would expose the armor to seawater.

3.4 **Jacket Markings.** The jacket shall be marked with meter markers at least every 5 meters, starting at zero from the buoy end.

4.0 CABLE PERFORMANCE REQUIREMENTS.

4.1 **General and Environmental.** The riser cable performance shall not be degraded by conditions typical of the working environment, including:

4.1.1 Continuous submergence in seawater over working life.

4.1.2 Temperatures from 0 to 25 degrees Centigrade.

4.1.3 Hydrostatic pressure equivalent to 4000 meters seawater (6000 psi).

4.1.4 Service Life. The Riser cable shall provide a minimum of 25 years of service while continuously submerged in a dynamic ocean environment (see section 2.0).

4.2 Mechanical

4.2.1 Diameter and weight (minimize) In general, the cable diameter and weight affect the rest of the system and should be minimized. However, the highest priority is weight in water and resistance to damage from bending. If improvements in either of these can be achieved at the expense of a slightly larger cable, then this is to be preferred.

4.2.2 Working Strength 6000 lbs.

4.2.3 Breaking Strength 30000 lbs. minimum.

4.2.4 Elongation. The strain on the optical package in the cable is not to exceed 0.65% at 6000lbs. load including initial constructional stretch.

4.2.5 Rotation. The mooring design does not include a swivel, therefore it is important that the cable be torque balanced as much as possible and strain induced rotation shall be minimal in keeping with good design practice.

4.2.6 Minimum Bend Radius. TBD. Needs to be storable and deployable from a drum.

4.2.7 Fatigue Life. The cable materials and construction shall be suitable for the dynamic loading of continuous operation as a buoy mooring cable. Section 2.0 describes the expected cyclic bending and loading conditions in detail.

4.2.8 Packaging. Standard cable reel suitable for shipping.

4.3 Optical

4.3.1 Fiber Count. There shall nominally be **four** single-mode optical fibers. Fibers shall be Corning "SMF 28" or other suitable fiber selected by cable vendor. Use of alternate fiber shall be by written agreement between vendor and APL. The optical specifications must be met over the specified cable service life during continuous operation under the conditions described in the "General and Environmental" and the "Mechanical" sections above.

4.3.2 Optical Attenuation. Attenuation in each fiber shall not exceed the following values under cable working conditions (see mechanical specifications for working condition values):

0.17 dB per kilometer at 1310 Nm. wavelength

0.17 dB per kilometer at 1550 Nm. Wavelength

4.3.3 Optical Attenuation Uniformity. No single point attenuation discontinuity in any fiber in the finished cable shall be greater than 0.15 dB at either 1310 Nm. or 1550nm. wavelengths, as measured with an OTDR.

4.3.4 Optical Dispersion. Individual fiber specifications for optical dispersion in the completed cable shall meet the pre-cabled fiber manufacturer's specifications for the fiber used, as measured by EIA/TIA 455-175.

4.3.5 Fiber Proof Test. Individual fibers will be proof tested at the time of manufacture to a minimum of 150kpsi.

4.3.6 Fiber Identification. Fibers or their over-jacketing shall be color coded or otherwise indelibly marked at least every meter for identification

4.4 Electrical

4.4.1 General. The cable will be used for electrical power transmission while submerged in the marine environment. The cable shall provide a minimum of two electrical conductors insulated from one another, and from seawater.

4.4.2 Working Voltage. The cable will be used at a working voltage between conductors, or between conductors and seawater, of up to 425 Volts DC. At this voltage, the maximum electrical stress present at any point in the cable insulation system shall be less than or equal to 2.0 kV/mm (51 volts/mil). The insulation system used must be suitable for continuous high D.C. electric field stress.

4.4.3 Insulation Resistance. The Insulation Resistance of each conductor in the asbuilt cable shall be a minimum of 3,000 Megohms per kilometer, measured at the working voltage of Section 5.4.1 above. The resistance shall be measured between the test conductor, and the other conductor(s) plus the cable armor plus any other metallic cable elements, tied together.

4.4.4 Conductor Resistance. The cable will be used at a working current of up to three ampere per conductor. The maximum as-built, as-cabled, round trip (two way) resistance of the two cable conductors in series shall be a maximum of 4.5 ohms per kilometer (nominally 2.25 ohms per kilometer per conductor, although equal resistances are not required), measured at a conductor temperature of 20 degrees C. The as-built conductor resistance shall have a tolerance of +/- 5%.

4.4.5 Production Testing. Each individually insulated conductor shall be tested for insulation resistance, before cable assembly, in a water bath. The test conditions and criteria for acceptance shall be as specified in Section 5.4.2 above. The completed cable shall be evaluated for Partial Discharge at the working voltage of Section 5.4.1 above. No detectable discharge is permitted, within the detection limits of the test equipment employed.

4.4.6 Conductor Identification. The individual conductors shall be color coded or otherwise made visually distinguishable from one another, either throughout their length, or at regular increments not to exceed 0.33 meter.

5.0 CABLE QUALIFICATION TESTS.

The cable manufacturer shall perform the following test at manufacturer expense and forward the results to APL prior to final acceptance by APL of the completed cable.

5.1 **Strain on the optical package** at 6000lbs. cable tension. The cable shall be tensioned to 6000 lbs. and the elongation of the optical package measured over ten cycles from 0 to 6000lbs. The total elongation due to initial constructional stretch and load strain on the cable shall not exceed 0.65% on the first through the tenth load cycle. Failure to meet this requirement is cause to reject the cable.

The following tests will be performed by APL or an independent test contractor at APL expense prior to final acceptance of the cable. Failure to meet the specified Cable Performance Requirements in section 4.0 is cause to reject the cable.

5.2 **Electrical.** A riser cable specimen will be subjected to conductor resistance and insulation resistance tests to obtain the as delivered values.

5.3 **Optical Static Attenuation.** The riser cable will be tested for optical attenuation at 1310Nm and 1550Nm wavelengths to obtain the as delivered values.

5.4 **Optical Characterization.** The optical attenuation in response to tensile loading will be measured.

5.5 **Mechanical Characterization.** A riser cable section will be tested for tension induced changes in elongation, diameter, torque and rotation. The riser cable will also be tested for yield and breaking strength, and for susceptibility to damage by repeated bending as described in Section 2.0.

6.0 DELIVERY.

Delivery shall be quoted FOB destination, Seattle, WA, 98105. Cable shall be delivered suitably packaged for transportation and storage. Cable shall be delivered in a continuous length. The anchor end of the cable (the end without the fish-bite braid) shall on the outside of the shipping drum and a minimum of five meters shall be accessible at both ends of the cable to allow testing on the shipping drum.

LOW POWER RSN SEAFLOOR CABLE SPECIFICATION

Version 1.0

1.0 INTRODUCTION

The University of Washington Applied Physics Lab (APL) is currently developing a seafloor observatory. The depth of the observatory is planned to be 3000 meters deep in seawater. The observatory design includes electro-optical cables to connect nodes in the system on the seafloor referred to as the **Seafloor Cables**.

2.0 CABLE PROPOSAL REQUIREMENTS.

Prospective vendors are invited to submit proposed cable designs and should include the following information:

2.1 Design and estimated performance documentation.
2.2 Description of the cable construction materials, approximate sectional dimension.
2.3 Cable weight per meter in air and seawater.
2.4 Estimated axial stiffness of the cable (EA). Load vs. strain curve should also be included.
2.5 Estimated strain induced rotation of the proposed cable design.
2.6 Cable cost.
2.7 Cable delivery time ARO.
2.8 Availability, cost, and delivery time for sample sections (~50-100 meters) of the proposed design.

3.0 CABLE CONSTRUCTION REQUIREMENTS.

3.1 **Length.** Cable shall be delivered in a continuous length of **5000 meters**. A minimum of five meters shall be accessible at both ends of the cable to allow for testing on the shipping drum. The design should not limit the ability of the vendor to make a 15000 meter length at a later date.
3.2 **Strength member.** The cable strength member shall be synthetic fiber consistent with a minimum seawater weight and good fatigue life over the service life.
3.3 **Jackets.** All sections of the cable shall be jacketed with a non-conductive polymer jacket. The outer jacket color shall be high visibility ORANGE. The jacket shall be free of any skips or gaps that would expose the armor to seawater.
3.4 **Jacket Markings.** The jacket shall be marked with meter markers at least every 5 meters, starting at zero from the buoy end.

4.0 CABLE PERFORMANCE REQUIREMENTS.

4.1 **General and Environmental.** The riser cable performance shall not be degraded by conditions typical of the working environment, including:
4.1.1 Continuous submergence in seawater over working life.
4.1.2 Temperatures from 0 to 25 degrees Centigrade.

4.1.3 Hydrostatic pressure equivalent to 4000 meters seawater (6000 psi).

4.1.4 Service Life. The Seafloor cables shall provide a minimum of 25 years of service while continuously submerged in an ocean environment (see section 2.0).

4.2 Mechanical

4.2.1 Diameter and weight (minimize) In general, the cable diameter and weight affect the rest of the system and should be minimized. However, the highest priority is weight in water and resistance to damage from bending. If improvements in either of these can be achieved at the expense of a slightly larger cable, then this is to be preferred.

4.2.2 Working Strength 300 lbs.

4.2.3 Breaking Strength 1500 lbs. minimum.

4.2.4 Elongation. The strain on the optical package in the cable is not to exceed 0.65% at 6000lbs. load including initial constructional stretch.

4.2.5 Minimum Bend Radius. TBD. Needs to be storable and deployable from a drum.

4.2.6 Fatigue Life. The cable materials and construction shall be suitable for the dynamic loading of continuous operation as a buoy mooring cable. Section 2.0 describes the expected cyclic bending and loading conditions in detail.

4.2.7 Packaging. Standard cable reel suitable for shipping.

4.3 Optical

4.3.1 Fiber Count. There shall nominally be **four** single-mode optical fibers. Fibers shall be Corning "SMF 28" or other suitable fiber selected by cable vendor. Use of alternate fiber shall be by written agreement between vendor and APL. The optical specifications must be met over the specified cable service life during continuous operation under the conditions described in the "General and Environmental" and the "Mechanical" sections above.

4.3.2 Optical Attenuation. Attenuation in each fiber shall not exceed the following values under cable working conditions (see mechanical specifications for working condition values):
0.17 dB per kilometer at 1310 Nm. wavelength
0.17 dB per kilometer at 1550 Nm. Wavelength

4.3.3 Optical Attenuation Uniformity. No single point attenuation discontinuity in any fiber in the finished cable shall be greater than 0.15 dB at either 1310 Nm. or 1550nm. wavelengths, as measured with an OTDR.

4.3.4 Optical Dispersion. Individual fiber specifications for optical dispersion in the completed cable shall meet the pre-cabled fiber manufacturer's specifications for the fiber used, as measured by EIA/TIA 455-175.

4.3.5 Fiber Proof Test. Individual fibers will be proof tested at the time of manufacture to a minimum of 150kpsi.

4.3.6 Fiber Identification. Fibers or their over-jacketing shall be color coded or otherwise indelibly marked at least every meter for identification

4.4 Electrical

4.4.1 General. The cable will be used for electrical power transmission while submerged in the marine environment. The cable shall provide a minimum of two electrical conductors insulated from one another, and from seawater.

4.4.2 Working Voltage. The cable will be used at a working voltage between conductors, or between conductors and seawater, of up to 425 Volts DC. At this voltage, the maximum electrical stress present at any point in the cable insulation system shall be less than or equal to 2.0 kV/mm (51 volts/mil). The insulation system used must be suitable for continuous high D.C. electric field stress.

4.4.3 Insulation Resistance. The Insulation Resistance of each conductor in the asbuilt cable shall be a minimum of 3,000 Megohms per kilometer, measured at the working voltage of Section 5.4.1 above. The resistance shall be measured between the test conductor, and the other conductor(s) plus the cable armor plus any other metallic cable elements, tied together.

4.4.4 Conductor Resistance. The cable will be used at a working current of up to three ampere per conductor. The maximum as-built, as-cabled, round trip (two way) resistance of the two cable conductors in series shall be a maximum of 4.5 ohms per kilometer (nominally 2.25 ohms per kilometer per conductor, although equal resistances are not required), measured at a conductor temperature of 20 degrees C. The as-built conductor resistance shall have a tolerance of +/- 5%.

4.4.5 Production Testing. Each individually insulated conductor shall be tested for insulation resistance, before cable assembly, in a water bath. The test conditions and criteria for acceptance shall be as specified in Section 5.4.2 above. The completed cable shall be evaluated for Partial Discharge at the working voltage of Section 5.4.1 above. No detectable discharge is permitted, within the detection limits of the test equipment employed.

4.4.6 Conductor Identification. The individual conductors shall be color coded or otherwise made visually distinguishable from one another, either throughout their length, or at regular increments not to exceed 0.33 meter.

5.0 CABLE QUALIFICATION TESTS.

The cable manufacturer shall perform the following test at manufacturer expense and forward the results to APL prior to final acceptance by APL of the completed cable.

The following tests will be performed by APL or an independent test contractor at APL expense prior to final acceptance of the cable. Failure to meet the specified Cable Performance Requirements in section 4.0 is cause to reject the cable.

5.1 **Electrical.** A riser cable specimen will be subjected to conductor resistance and insulation resistance tests to obtain the as delivered values.

5.2 **Optical Static Attenuation.** The riser cable will be tested for optical attenuation at 1310Nm and 1550Nm wavelengths to obtain the as delivered values.

5.3 **Optical Characterization.** The optical attenuation in response to tensile loading will be measured.

5.4 **Mechanical Characterization.** A riser cable section will be tested for tension induced changes in elongation, diameter, torque and rotation. The riser cable will also be tested for yield and breaking strength, and for susceptibility to damage by repeated bending as described in Section 2.0.

6.0 DELIVERY.

Delivery shall be quoted FOB destination, Seattle, WA, 98105. Cable shall be delivered suitably packaged for transportation and storage. Cable shall be delivered in a continuous length. A minimum of five meters shall be accessible at both ends of the cable to allow testing on the shipping drum.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00004**
For:	Seacon Dry Mate Connectors
Type:	Budgetary Quote
Date:	Aug 22, 2008
Company:	MECCO
Requested By:	McGinnis

Notes:

Quotation

MECCO, INC
15614 Main St. NE
PO Box 790
Duvall, WA 98019
PH (425)788-4522
Fx (425)788-0639

To:
Tim McGinnis
Univeristy of Washington, Applied Physics Lab
Phone (206) 543-1346
Fax:
tmcginnis@apl.washington.edu

Quote 80922-K
Date: 09/22/08
FOB San Diego
Terms: Net 30 or credit card

Item	Part#	Description	Qty 1-3	Qty 4-10	Qty 11-25	Qty 50
1	MINK-10 (2#14, 8#20)-FCRL	Minicon Flanged Bulkhead Connector, 10-conductor, (2) 14 awg, (8) 20 awg, stainless steel	$461.90	$396.50	$346.90	$330.00
2	MINK-10 (2#14,8#20)-BCRL	Minicon 3/4-20 Bulkhead Connector, 10-conductor, (2) 14 awg, (8) 20 awg, stainless steel	$401.40	$344.60	$301.20	$286.00
3	Cable Assembly	MINK-10 (2#14, 8#20)-CCPL cable connector molded to Falmat FMXCAT52218K12 cable. Price does not include cable.	$561.70	$501.70	$455.80	$433.00
4	MINK-10-CCP-PBOF	MINK-10 (2#14, 8#20)-CCPL cable connector , pressure balanced, oil-filled.	$1,740.00	$1,100.70	pending	
			Qty 1-5	Qty 6-24	Qty 25-50	
5	Cable Assembly	XSEE-10-CCP molded to Falmat FMXCAT52218K12	$206.10	$171.50	$156.60	

Kathy Judd kathy@meccoinc.com

Subject: FW: Seacon connector quote for OOI (NEPTUNE)
From: "Tim McGinnis" <tmcginnis@apl.washington.edu>
Date: Mon, 22 Sep 2008 13:19:29 -0700
To: "'Gary Harkins'" <harkins@apl.washington.edu>, "'Mike Harrington'" <mikeh@apl.washington.edu>, "'Skip Denny'" <denny@apl.washington.edu>

This Minicon is a reasonable connector to use for budgeting. It is also available with an oil-filled hose, which might be useful.

NC has paid the NRE to develop an epoxy CCP (cable connector plug) that would fir the Minicon bulkhead and has ordered 2 pieces. It is a 10 pin connector with 2 x #14 and 8 x #20 conductors. They will not retain any IP – it will be available to everyone.

http://wwwseacon-usa.com/catalog/MINI-CON_04-22-08.pdf

Tim McGinnis
Applied Physics Lab
University of Washington
1013 NE 40th St
Seattle, WA 98105
+1-206-543-1346
tmcginnis@apl.washingtonedu

From: Kathy Judd [mailto:kathy@meccoinc.com]
Sent: Monday, September 22, 2008 11:28 AM
To: Tim McGinnis
Cc: Mike Chapman
Subject: Re: Seacon connector quote for OOI (NEPTUNE)

Hi Tim,

Attached is a preliminary quote. I will update this with the PBOF prices this afternoon.

Kind regards,
Kathy Judd

> ----- Original Message -----
> **From:** Tim McGinnis
> **To:** 'Mike Chapman'
> **Cc:** 'Tami Osborne' ; 'Kathy Judd'
> **Sent:** Friday, September 19, 2008 4:03 PM
> **Subject:** RE: Seacon connector quote for OOI (NEPTUNE)
>
> Thanks. I assume that you think that the epoxy CCP is a good way to go?
>
> Will UVic have any proprietary ownership or will anybody be able to buy them?
>
> Tim
>
> ---
>
> **From:** Mike Chapman [mailto:m.e.chapman@att.net]
> **Sent:** Friday, September 19, 2008 2:45 PM
> **To:** Tim McGinnis
> **Cc:** Tami Osborne; Kathy Judd

Subject: Re: Seacon connector quote for OOI (NEPTUNE)

Hello Tim,

I will let Kathy or Tami send you the prices below, but, to answer your question about the epoxy ccp for the MINK's, yes, UVic has paid for the NRE for an epoxy CCP. It's in process right now. They will get two of the initial parts for testing purposes.

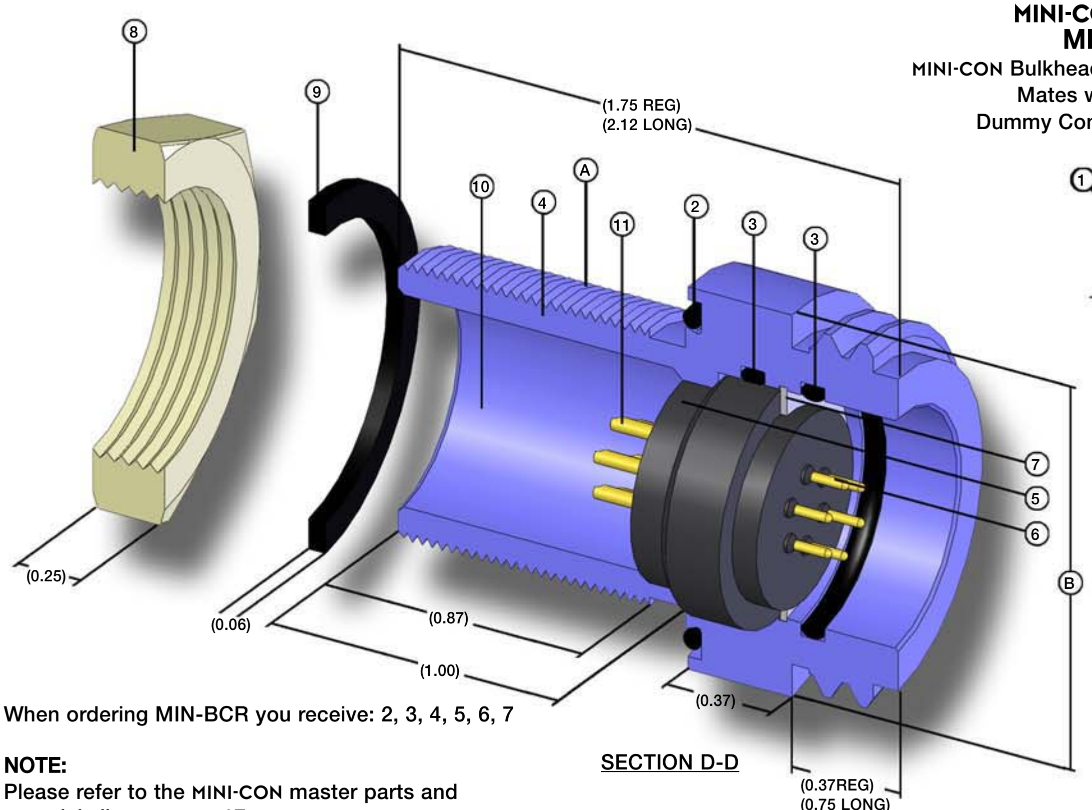
Regards, Mike

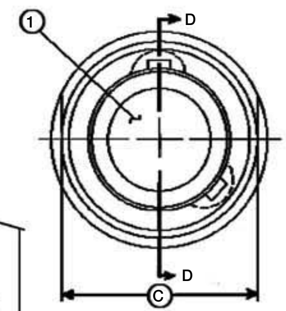
> ----- Original Message -----
> **From:** Tim McGinnis
> **To:** 'Mike Chapman' ; Mike Chapman
> **Sent:** Friday, September 19, 2008 2:39 PM
> **Subject:** Seacon connector quote for OOI (NEPTUNE)
>
> Mike, Kathy & Tami:
>
> We are preparing for an OOI-RSN design review and have been asked for pricing for the various system components.
>
> It would be very helpful if we could get (budgetary?) pricing for quantities of 1, 10 & 50 (or wherever the price breaks are) for the following:
>
> MINK-10-FCR
> MINK-10-BCR
> MINK-10-CCP molded to Falmat FMXCAT52218K12 cable
> MINK-10-CCP-PBOF
> XSEE-10-CCP molded to Falmat FMXCAT52218K12 cable
>
> The purchases would be at least 1-2 years out.
>
> For the last item, did NEPTUNE Canada end up doing the XSEE epoxy insert in the CCP that mated with the MINK-BCR?
>
> Thanks – have a nice weekend,
>
> Tim McGinnis
> Applied Physics Lab
> University of Washington
> 1013 NE 40th St
> Seattle, WA 98105
> +1-206-543-1346
> tmcginnis@apl.washington.edu

Tim McGinnis MINK-10.xls	**Content-Type:**	application/vnd.ms-excel
	Content-Encoding:	base64

MINI-CON SERIES
MIN-BCR

MINI-CON Bulkhead Connector Receptacle
Mates with MIN-CCP
Dummy Connector: MIN-DSP





NOTES:
Reference pages 18-29 for pattern availability.

When ordering MIN-BCR you receive: 2, 3, 4, 5, 6, 7

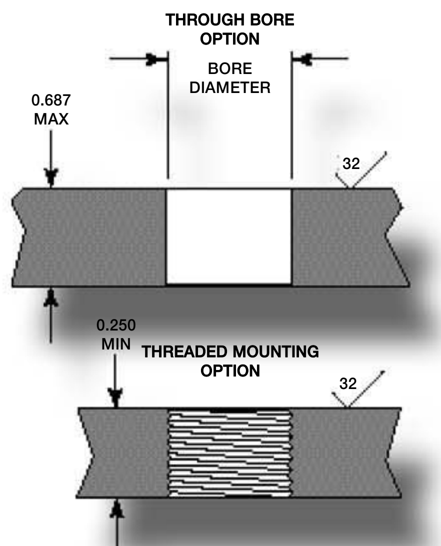
NOTE:
Please refer to the MINI-CON master parts and materials list on page 17.

CONNECTOR	A - MOUNTING THREAD	B - DIAMETER (INCHES)	2 - O-RING	7 - SPIROLOX	3 - O-RING	C - WRENCH FLATS (INCHES)	8 - HEX NUT ACROSS FLATS (INCHES)	8 - HEX NUT ACROSS POINTS (INCHES)	9 - WASHER OD (INCHES)
MIND-BCR	3/8-24 UNF-2A	0.75	2-013	VH-31	2-011	0.62	0.62	0.72	0.62
MINE-BCR	1/2-20 UNF-2A	0.87	2-015	VH-43	2-013	0.75	0.75	0.86	0.75
MING-BCR	5/8-24 UNEF-2A	1.00	2-018	UR50	2-014	0.87	0.88	1.00	0.88
MINK-BCR	3/4-20 UNEF-2A	1.12	2-019	UR62	2-016	1.00	1.00	1.16	1.00
MINL-BCR	7/8-20 UNEF-2A	1.25	2-021	UR75	2-018	1.12	1.13	1.31	1.13
MINM-BCR	1-20 UNEF-2A	1.37	2-023	UR81	2-019	1.25	1.25	1.44	1.25
MINO-BCR	1 1/8-16 UN-2A	1.62	2-026	UR106	2-023	1.50	1.50	1.75	1.50
MINP-BCR	1 1/4-16 UN-2A	1.75	2-028	UR118	2-025	1.62	1.63	1.88	1.63
MINQ-BCR	1 3/8-16 UN-2A	1.87	2-029	UR137	2-028	1.75	1.75	2.00	1.75
MINR-BCR	1 1/2-16 UN-2A	2.00	2-029	UR150	2-029	1.87	1.88	2.16	1.88
MINT-BCR	2-16 UN-2A	2.50	2-034	UR175	2-031	2.37	2.38	2.75	2.38
MINU-BCR	2 1/4-16 UN-2A	2.75	2-036	UR200	2-033	2.62	2.63	3.03	2.63
MINX-BCR	2 3/4-16 UN-2A	3.50	2-041	UR250	2-037	3.15	3.16	3.63	3.16

BCR MOUNTING REQUIREMENTS

SIZE	BORE Ø +0.015 -0.000 (INCHES)	BCR/L * MOUNTING TORQUE (INCH-POUNDS)
D	0.375	30-35
E	0.500	50-55
G	0.625	65-85
K	0.750	75-100
L	0.875	90-110
M	1.000	120-150
O	1.125	130-160
P	1.250	140-170
Q	1.375	150-180
R	1.500	170-220
T	2.000	210-250
U	2.250	220-260
X	2.750	240-280

* Torque specified is for dry metal threads.

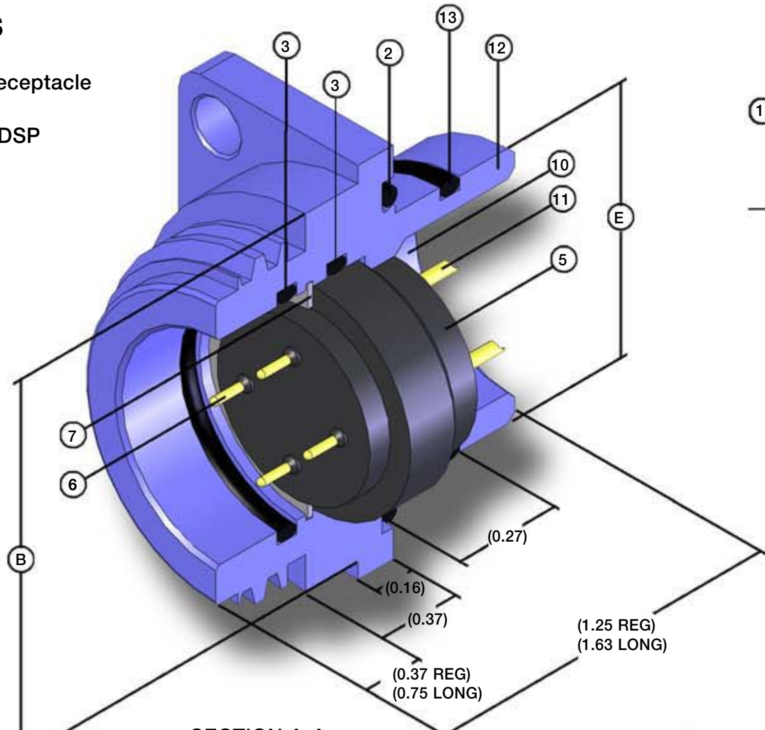


NOTES:

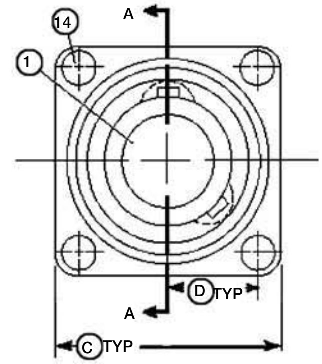
1. Bore must be perpendicular to spot face.
2. Spotface diameter to be equal or greater than the connector diameter.
3. If threaded mount is used, lead thread chamfer is not to exceed diameter shown in bore column.

MINI-CON SERIES
MIN-FCR

MINI-CON Flange Connector Receptacle
Mates with MIN-CCP
Dummy Connector: MIN-DSP



SECTION A-A



NOTE:
Please refer to the MINI-CON master parts and materials list on page 17.

NOTES:
Reference pages 18-29 for pattern availability.

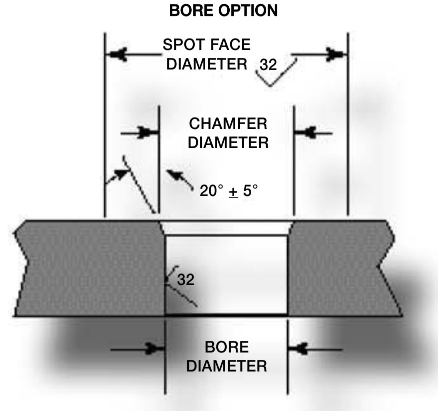
When ordering MIN-FCR you receive: 2, 3, 5, 6, 7, 12, 13

CONNECTOR	B - DIAMETER (INCHES)	C - SQUARE (INCHES)	D - MOUNTING HOLE LOCATION (INCHES)	E - DIAMETER (INCHES)	13 - O-RING	7 - SPIROLOX	2 - O-RING	SOCKET HEAD CAPSCREW	3 - O-RING
MIND-FCR	0.75	0.87	0.335	0.373	2-010	VH-31	2-013	4-40 UNC-2A	2-011
MINE-FCR	0.87	1.00	0.387	0.498	2-012	VH-43	2-015	4-40 UNC-2A	2-013
MING-FCR	1.00	1.12	0.453	0.685	2-015	UR50	2-018	4-40 UNC-2A	2-014
MINK-FCR	1.12	1.25	0.510	0.748	2-016	UR62	2-019	6-32 UNC-2A	2-016
MINL-FCR	1.25	1.37	0.562	0.873	2-018	UR75	2-021	6-32 UNC-2A	2-018
MINM-FCR	1.37	1.50	0.593	0.998	2-020	UR81	2-023	8-32 UNC-2A	2-019
MINO-FCR	1.62	1.75	0.723	1.123	2-022	UR106	2-026	8-32 UNC-2A	2-023
MINP-FCR	1.75	1.87	0.777	1.248	2-024	UR118	2-028	8-32 UNC-2A	2-025
MINQ-FCR	1.87	2.00	0.831	1.373	2-026	UR137	2-029	10-24 UNC-2A	2-028
MINR-FCR	2.00	2.12	0.884	1.498	2-028	UR150	2-029	10-24 UNC-2A	2-029
MINT-FCR	2.50	2.62	1.043	1.998	2-032	UR175	2-034	1/4-20 UNC-2A	2-031
MINU-FCR	2.75	2.87	1.130	2.248	2-034	UR200	2-036	1/4-20 UNC-2A	2-033
MINX-FCR	3.50	3.62	1.470	2.748	2-038	UR250	2-041	3/8-16 UNC-2A	2-037

FCR MOUNTING REQUIREMENTS

SIZE	BORE Ø +0.002 -0.000 (INCHES)	CHAMFER Ø ±0.010 (INCHES)	*SPOTFACE Ø ±0.015 (INCHES)	**SPOTFACE Ø ±0.015 (INCHES)
D	0.375	0.425	0.69	1.18
E	0.500	0.550	0.87	1.37
G	0.687	0.727	1.00	1.56
K	0.750	0.800	1.12	1.75
L	0.875	0.915	1.25	1.87
M	1.000	1.040	1.31	2.12
O	1.125	1.175	1.50	2.44
P	1.250	1.290	1.62	2.62
Q	1.375	1.425	1.81	2.81
R	1.500	1.540	1.87	3.00
T	2.000	2.050	2.50	3.75
U	2.250	2.290	2.75	4.00
X	2.750	2.800	3.31	5.06

THROUGH BORE OPTION



NOTES: CHAMFER IS TO BE 20° ± 5°

* This dimension is to be used if spotface is less than or equal to 0.001 inches deep.

** This dimension is to be used if spotface is greater than 0.001 inches deep.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00005**
For:	Lambda 400 Volt Power Supply
Type:	Budgetary Quote
Date:	Aug 26, 2008
Company:	PSI
Requested By:	Harrington

Notes:

Subject: Lambda DC Power supplies
From: "Doug Green" <doug@psirep.com>
Date: Tue, 26 Aug 2008 13:56:04 -0700
To: "Michael Harrington" <mikeh@apl.washington.edu>
CC: "'Greg Gohsman'" <greg@psirep.com>

Hello Michael,

Greg Gohsman called me today and indicated that you have an upcoming requirement for a 1-2kw DC power supply capable of delivering 400 volts DC.

Here are some options and associated pricing for budgetary purposes. Please let me know if you have any questions or if you require an official quote.

Option 1: Lambda Genesys Half Rack 600-1.3. This is a 780 Watt programmable power supply delivering up to 600 volts at 1.3amp max. Price on this unit is $1260

Option 2: Lambda Genesys 600-2.6. this is a 1560 watt programmable supply delivering up to 600 volts at a max of 2.6amps DC. Price is $1560

Option 3:The Lambda Genesys 600-5.5 is a 3300 watt programmable unit which delivers up to 600 volts DC at a max of 5.5amps. This unit runs $2990

I have included a full brochure on the Genesys series power supply. It is a rather large file, so if you do not receive it, please let me know and I can mail you a hard copy and email a short form version.

Please feel free to contact me should you have any questions or require additional information.

Best Regards,

Doug Green

PSI Solutions, Inc.
PO Box 24058, Federal Way, WA 98093
Phone 253-838-9263, Fax 253-942-4700, Cell 206-510-3262

Find All Your Solutions at www.psirep.com
Representing Leading Manufacturers of Test Instrumentation, Imaging and Embedded Products

Doug Green (doug@psirep.com) <doug@psirep.com>
Business Development Manager
PSI Solutions Inc.

PSI Instrumentation Line Card DG.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

Lambda Genesys Long Form.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

General Specifications Genesys™ Full Rack 1U 750W/1500W

2.1 INPUT CHARACTERISTICS

1. Input voltage/freq. (*9)	85~265Vac continuous, 47~63Hz, single phase
2.Power Factor	0.99 @100/200Vac, rated output power.
3. EN61000-3-2,3 compliance	Complies with EN61000-3-2 class A and EN61000-3-3 at 20~100% output power.
4. Input current 100/200Vac	**750W** :10.5A / 5A, **1500W** :21A / 11A
5. Inrush current 100/200Vac	**750W** :Less than 25A, **1500W** :Less than 50A
6. Hold-up time	More than 20mS , 100Vac , at 100% load.

2.2 POWER SUPPLY CONFIGURATION

1. Parallel Operation	Up to Four (4) identical units may be connected in Master/Slave Mode with single wire connection. In Advanced parallel feature, the current of Master Unit, multiplied by number of units connected in parallel, is made available on digital interface and displayed on front panel of Master unit. Remote analog current monitor of the Master is scaled to output current of the Master unit (only).
2. Series Operation	Possible (with external diodes), up to identical 2 units with total output not to exceed +/-600V from chassis ground.

2.3 ENVIRONMENTAL CONDITIONS

1. Operating temperature	0~50°C, 100% load.
2. Storage temperature	-20~70°C
3. Operating humidity	30~90% RH (non-condensing).
4. Storage humidity	10~95% RH (non-condensing).
5. Vibration and Shock	MIL-STD-810F, method 514.5 , The EUT is fixed to the vibrating surface. Less than 20G , half sine , 11mSec. Unit is unpacked. ASTM D4169, Standard Practice for Performance Testing of Shipping Containers and Systems, Shipping Unit: Single Package Assurance Level: Level II; Acceptance Criteria: Criterion 1 - No product damage Criterion 2 - Packaging is intact, Distribution Cycle: 12 - Air (intercity) and motor freight (local), unitized is used
6. Altitude	Operating: 10000ft (3000m), Derate output current by 2%/100m above 2000m, Non operating: 40000ft (12000m).

2.4 EMC

1. Applicable Standards:	
2. ESD	IEC1000-4-2. Air-disch.-8kV, contact disch.-4kV
3. Fast transients	IEC1000-4-4. 2kV
4. Surge immunity	IEC1000-4-5. 1kV line to line, 2kV line to ground
5. Conducted immunity	IEC1000-4-6, 3V
6. Radiated immunity	IEC1000-4-3, 3V/m
7. Conducted emission	EN55022B,FCC part 15J-B,VCCI-B
8. Radiated emission	EN55022A,FCC part 15-A,VCCI-A
9. Voltage dips	EN61000-4-11

2.5 SAFETY

1.Applicable standards:	**CE Mark, UL60950,EN60950 listed .** Vout<60V:Output is SELV , IEEE/Isolated analog are SELV. 60<Vout<400V: Output is hazardous, IEEE/Isolated analog are SELV. 400<Vout<600V:Output is hazardous, IEEE/Isolated analog are not SELV.
2.Withstand voltage	Vout<60V models :Input-Outputs (SELV): 3.0kVrms 1min, Input-Ground: 2.0kVrms 1min. 60<Vout<600V models: Input-Haz. Output: 2.5kVrms 1min, Input-SELV: 3kVrms 1min. Hazardous Output.-SELV: 1.9kVrms 1min, Hazardous Output-Ground:1.9kVrms 1min. Input-Ground: 2kVrms 1min.
3.Insulation resistance	More than 100Mohm at 25°C, 70% RH, 500Vdc

2.6 MECHANICAL CONSTRUCTION

1. Cooling	Forced air flow: from front to rear. No ventilation holes at the top or bottom of the chassis; Variable fan speed.
2. Dimensions (WxHxD)	W: 422.6mm / 16.64", H: 43.7mm / 1.72", D: 432.8mm / 17", excluding connectors, encoders, handles, etc.
3. Weight	**750W** :7kg / 15lbs, **1500W** :8.5kg / 18lbs
4. AC Input connector (with Protective Cover)	750W: IEC320 AC Inlet. 1500W: Screw terminal block, Phoenix P/N: FRONT-4-H-7.62, with strain relief
5.Output connectors	6V to 60V models: Bus-bars (hole Ø 6.5mm). 80V to 600V models: Mating plug, Phoenix P/N: GIC 2.5/4-ST-7.62.

2.7 WARRANTY

1. Warranty	5 years.

*1: Minimum voltage is guaranteed to maximum 0.2% of Vo Rated.
*2: Minimum current is guaranteed to maximum 0.4% of Io Rated
*3: At maximum output power.
*4: 85~132Vac or 170~265Vac, constant load.
*5: From No-load to Full-load, constant input voltage.
*6: For load voltage change, equal to the unit voltage rating, constant input voltage.
*7: For 6V models the ripple is measured at 2~6V output voltage and full output current. For other models, the ripple is measured at 10~100% output voltage and full output current.
*8: Time for the output voltage to recover within 0.5% of its rated for a load change 10~90% of rated output current, Output set-point:10~100%.
Accuracy -Values have been calculated at Vo Rated & Io Rated
*9: For cases where conformance to various safety standards (UL, IEC etc.) is required, to be described as 100-240Vac (50/60Hz).

All specifications subject to change without notice.

Genesys™ 2U 3.3kW Specifications

1.0 MODEL	GEN	8-400	10-330	15-220	20-165	30-110	40-85	60-55	80-42	100-33	150-22	300-11	600-5.5
1.Rated Output Voltage (*1)	V	8	10	15	20	30	40	60	80	100	150	300	600
2.Rated Output Current (*2)	A	400	330	220	165	110	85	55	42	33	22	11	5.5
3.Rated Output Power	W	3200	3300	3300	3300	3300	3400	3300	3360	3300	3300	3300	3300

1.1 CONSTANT VOLTAGE MODE

		8-400	10-330	15-220	20-165	30-110	40-85	60-55	80-42	100-33	150-22	300-11	600-5.5
1.Max.line regulation (0.01% of rated Vo+2mV)(*6)	mV	2.8	3	3.5	4	5	6	8	10	12	17	32	62
2.Max load regulation (0.015% of ratedVo+5mV)(*7)	mV	6.2	6.5	7.25	8	9.5	11	14	17	20	27.5	50	95
3.Ripple and noise p-p 20MHz (*8)	mV	60	60	60	60	60	60	60	80	100	100	300	500
4.Ripple r.m.s 5Hz~1MHz	mV	8	8	8	8	8	8	8	8	8	25	100	120
5.Remote sense compensation/wire	V	2	2	2	2	5	5	5	5	5	5	5	5
6.Temperature coefficient	PPM/°C	100PPM/°C of rated output voltage, following 30 minutes warm-up											
7.Temperature stability		0.05% of rated Vout over 8hrs interval following 30 minutes warm-up. Constant line, load & temp.											
8.Warm-up drift		Less than 0.05% of rated output voltage+2mV over 30 minutes following power On.											
9.Up-prog. response time, 0~Vo Rated (*9)	mS	80						150					250
10.Down-prog response time No-load (*10)	mS	20	100		160				300				500
10.Down-prog response time Full-load (*9)	mS	500	600	700	800	900	1000	1100	1200	1500	2000	3500	4000
11.Transient response time	mS	Time for output voltage to recover within 0.5% of its rated output for a load change 10-90% of rated output current. Output set-point: 10-100%, local sense. Less than 1mSec for models up to and including 100V. 2msec for models above 100V											

1.2 CONSTANT CURRENT MODE

		8-400	10-330	15-220	20-165	30-110	40-85	60-55	80-42	100-33	150-22	300-11	600-5.5
1.Max.line regulation (0.01% of Io rated+2mA)(*6)	mA	42	35	24	18.5	13	10.5	7.5	6.2	5.3	4.2	3.1	2.6
2.Max.load regulation (0.02% of Io rated+5mA)(*11)	mA	85	71	49	38	27	22	16	13.4	11.6	9.4	7.2	6.1
3.Ripple r.m.s 5Hz~1MHz. (*12)	mA	1300	1200	880	660	300	200	100	80	70	60	20	10
4.Load regulation thermal drift		Less than 0.1% of rated output current over 30 minutes following load change.											
5.Temperature coefficient	PPM/°C	200PPM/ºC from rated output current, following 30 minutes warm-up.											
6.Temperature stability		0.05% of rated Iout over 8hrs. interval following 30minutes warm-up. Constant line, load & temperature.											
7.Warm-up drift		8V~20V models: Less than 0.5% of rated output current over 30 minutes following power On. 30V~600V models: Less than 0.25% of rated output current over 30 minutes following power On.											

1.3 PROTECTIVE FUNCTIONS

	8-400	10-330	15-220	20-165	30-110	40-85	60-55	80-42	100-33	150-22	300-11	600-5.5
1. OCP	0~105% Constant Current											
2. OCP Foldback	Output shut down when power supply change from CV to CC. User selectable.											
3. OVP type	Inverter shut-down, manual reset by AC input recycle or by OUT button or by communication port command.											
4. OVP trip point	0.5~10V	0.5~12V	1~18V	1~24V	2~36V	2~44V	5~66V	5~88V	5~110V	5~165V	5~330V	5~660V
5. Output Under Voltage Limit	Preset by front panel or communication port. Prevents from adjusting Vout below limit.											
6. Over Temperature Protection	User selectable , latched or non-latched.											

1.4 ANALOG PROGRAMMING AND MONITORING

1.Vout Voltage Programming	0~100%, 0~5V or 0~10V, user select. Accuracy and linearity:±0.5% of rated Vout.
2.Iout Voltage Programming (*13)	0~100%, 0~5V or 0~10V, user select. Accuracy and linearity:±1% of rated Iout.
3.Vout Resistor Programming	0~100%, 0~5/10kohm full scale, user select., Accuracy and linearity: ±1% of rated Vout.
4.Iout Resistor Programming (*13)	0~100%, 0~5/10kohm full scale, user select. Accuracy and linearity:±1.5% of rated Iout.
5.On/Off control (rear panel)	By Voltage: 0.6V = Disable, 2-15V = enable (default) or dry contact, user selectable logic
6.Output Current monitor (*13)	0~5V or 0~10V, Accuracy:±1%, user selectable.
7.Output Voltage monitor	0~5V or 0~10V, Accuracy:±1%, user selectable.
8.Power Supply OK signal	Yes. TTL high-OK, 0V (500ohm impedance)-Fail
9. CV/CC Indicator	CV: TTL high (4~5V) source 10mA, CC: TTL low (0~0.6V), sink current: 10mA.
10. Enable/Disable	Dry contact. Open:off, Short: on. Max. voltage at Enable/Disable in: 6V.
11. Local/Remote analog control	By electrical signal or Open/Short: 0~0.6V or short: Remote, 4~5V or open: Local.
12. Local/Remote analog control Indicator	Open collector, Local: Off, Remote: On. Maximum voltage: 30V, maximum sink current: 10mA.

1.5 FRONT PANEL

1.Control functions	Vout/ Iout manual adjust by separate encoders (coarse and fine adjustment selectable). OVP/UVL manual adjust by Volt. Adjust encoder. On/Off, Output ON/OFF, Re-start modes (auto, safe), Foldback control (CV to CC), Go to local control. Address selection by Voltage (or current) adjust encoder. Number of addresses:31. Re-start modes (automatic restart, safe mode). Baud rate selection: 1200, 2400, 4800, 9600 and 19,200, by current adjust encoder. Parallel Master Slave:Hx, where x = Slaves 0 up to four.
2.Display	Voltage: 4 digits, Accuracy: 0.5% of rated output Voltage ±1 count. Current: 4 digits, Accuracy: 0.5% of rated output current ±1 count. Voltmeter is user selectable to read either local voltage (at power supply) or remote voltage (at the load).
3.Indications	ADDR., OVP/UVL, V/A, FOLD, REM./LOCAL, OUT ON/OFF, LFP/UFP, CC/CV: GREEN LED's. ALRM (OVP, OTP, FOLD, AC FAIL): RED LED

1.6 DIGITAL PROGRAMMING & READBACK

Model	V	8	10	15	20	30	40	60	80	100	150	300	600
1. Remote Voltage Programming (16 bit)													
Resolution (0.012% of Vo Rated)	mV	0.96	1.2	1.8	2.4	3.6	4.8	7.2	9.6	12	18	36	72
Accuracy (0.05% of Vo Rated+0.05% of Vo Actual)	mV	8	10	15	20	30	40	60	80	100	150	300	600
2. Remote Current Programming (16 bit)													
Resolution (0.012% of Io Rated)	mA	48	39.6	26.4	19.8	13.2	10.2	6.6	5	4	2.6	1.3	0.7
Accuracy (0.2% of Io Rated+0.1% of Io Actual)(*13)	mA	1200	990	660	495	330	255	165	126	99	66	33	16.5
3. Readback Voltage													
Resolution (0.012% of Vo Rated)	mV	0.96	1.2	1.8	2.4	3.6	4.8	7.2	9.6	12	18	36	72
Accuracy (0.1% Vo Rated+0.1% of Vo Actual)	mV	16	20	30	40	60	80	120	160	200	300	600	1200
4. Readback Current													
Resolution (0.012% of Io Rated)	mA	48	39.6	26.4	19.8	13.2	10.2	6.6	5.0	4.0	2.6	1.3	0.7
Accuracy (0.3% of Io Rated+0.1% of Io Actual)(*13)	mA	1600	1320	880	660	440	340	220	168	132	88	44	22
5. OVP/UVL Programming													
Resolution (0.1% of Vo Rated)	mV	8	10	15	20	30	40	60	80	100	150	300	600
Accuracy (1% of Vo Rated)	mV	80	100	150	200	300	400	600	800	1000	1500	3000	6000

All specifications subject to change without notice.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00006**
For:	Network Switch
Type:	Budgetary Quote
Date:	Aug 25, 2008
Company:	PSI
Requested By:	Harrington

Notes:

PSI Solutions Incorporated
P.O. Box 24058, Federal Way WA 98093
Phone 253-838-9263, Fax 253-942-4700
Find Your Solution at www.psirep.com

Quote

12298

Date: 08/25/2008

Bill To:
University Of Washington
Accounts Payable
PO Box 351130
Seattle, WA 98105
USA

Please make your Purchase Order to:
PSI Solutions Incorporated
PO Box 24058
Federal Way, WA 98093

Ship to Attention: Michael Harrington

Please fax your Purchase Order to: 253-942-4700

REQ DATE:	08/25/2008	**TERMS:**	Net 30
OUR REF#:	12298	**FOB:**	Brea, CA
PHONE:	206-543-6857	**SALES PERSON:**	Greg Gohsman 509-674-2962
FAX#:	206-543-6785		

PSI Solutions Thanks You for the Opportunity to Provide this Quote

Item#	Part Number/Description	Qty	UM	Price	Total	Delivery
1	**EDS-510A-3GT-T** Moxa Managed Ethernet Switch with Three 10/100/1000 BaseTx and Seven 10/100 BaseTx Ports with VLAN,IGMP Snooping and QoS; -40 to 75C	1	EA	$ 1,609.08	$ 1,609.08	4-6 Weeks ARO
2	**SFP-1GLXLC-T** Moxa SFP Interface Module with One 1000Lx Port, LC Connector 10Km Supported, with Operating Temp. -40 to 75C	1	EA	$ 532.68	$ 532.68	4-6 Weeks ARO
3	**SFP-1GLHXLC-T** Moxa SFP Interface module with 1 1000LHx Port,LC connector 40Km Supported; w/Operating Temp. -40 to 75C	1	EA	$ 1,443.48	$ 1,443.48	4-6 Weeks ARO
4	**WK-46** Moxa Wall Mount Kit for EDS Series	1	EA	$ 10.00	$ 10.00	50 in Stock
5	**EDS-510A-3GT-T** Moxa Managed Ethernet Switch with Three 10/100/1000 BaseTx and Seven 10/100 BaseTx Ports with VLAN,IGMP Snooping and QoS; -40 to 75C	10	EA	$ 1,539.12	$ 15,391.20	

Price, Availability and Delivery Info Subject to Change
Quote is Valid for a Period of 30 days from Issue Date
Matrox Items are Non-Refundable, Non-Returnable
Taxes and Shipping Costs are not quoted unless requested by Buyer

Item Total:

Freight Estimate

Total Quote:

PSI Solutions Incorporated
P.O. Box 24058, Federal Way WA 98093
Phone 253-838-9263, Fax 253-942-4700
Find Your Solution at www.psirep.com

Quote

12298

Date: 08/25/2008

Bill To:
University Of Washington
Accounts Payable
PO Box 351130
Seattle, WA 98105
USA

Please make your Purchase Order to:
PSI Solutions Incorporated
PO Box 24058
Federal Way, WA 98093

Ship to Attention: Michael Harrington

Please fax your Purchase Order to: 253-942-4700

REQ DATE: 08/25/2008
OUR REF#: 12298
PHONE: 206-543-6857
FAX#: 206-543-6785

TERMS: Net 30
FOB: Brea, CA
SALES PERSON: Greg Gohsman
509-674-2962

PSI Solutions Thanks You for the Opportunity to Provide this Quote

Item#	Part Number/Description	Qty	UM	Price	Total	Delivery
6	**SFP-1GLXLC-T** Moxa SFP Interface Module with One 1000Lx Port, LC Connector 10Km Supported, with Operating Temp. -40 to 75C	10	EA	$ 509.52	$ 5,095.20	
7	**SFP-1GLHXLC-T** Moxa SFP Interface module with 1 1000LHx Port,LC connector 40Km Supported; w/Operating Temp. -40 to 75C	10	EA	$ 1,380.72	$ 13,807.20	
8	**WK-46** Moxa Wall Mount Kit for EDS Series	10	EA	$ 10.00	$ 100.00	
9	**EDS-510A-3GT-T** Moxa Managed Ethernet Switch with Three 10/100/1000 BaseTx and Seven 10/100 BaseTx Ports with VLAN,IGMP Snooping and QoS; -40 to 75C	20	EA	$ 1,486.65	$ 29,733.00	
10	**SFP-1GLXLC-T** Moxa SFP Interface Module with One 1000Lx Port, LC Connector 10Km Supported, with Operating Temp. -40 to 75C	20	EA	$ 492.15	$ 9,843.00	
11	**SFP-1GLHXLC-T** Moxa SFP Interface module with 1 1000LHx Port,LC connector 40Km Supported; w/Operating Temp. -40 to 75C	20	EA	$ 1,333.65	$ 26,673.00	

Price, Availability and Delivery Info Subject to Change
Quote is Valid for a Period of 30 days from Issue Date
Matrox Items are Non-Refundable, Non-Returnable
Taxes and Shipping Costs are not quoted unless requested by Buyer

Item Total:

Freight Estimate

Total Quote:

PSI Solutions Incorporated
P.O. Box 24058, Federal Way WA 98093
Phone 253-838-9263, Fax 253-942-4700
Find Your Solution at www.psirep.com

Quote

12298

Date: 08/25/2008

Bill To:
University Of Washington
Accounts Payable
PO Box 351130
Seattle, WA 98105
USA

Please make your Purchase Order to:
PSI Solutions Incorporated
PO Box 24058
Federal Way, WA 98093

Ship to Attention: Michael Harrington

Please fax your Purchase Order to: 253-942-4700

REQ DATE: 08/25/2008
OUR REF#: 12298
PHONE: 206-543-6857
FAX#: 206-543-6785

TERMS: Net 30
FOB: Brea, CA
SALES PERSON: Greg Gohsman
509-674-2962

PSI Solutions Thanks You for the Opportunity to Provide this Quote

Item#	Part Number/Description	Qty	UM	Price	Total	Delivery
12	**WK-46** Moxa Wall Mount Kit for EDS Series	20	EA	$ 10.00	$ 200.00	

Price, Availability and Delivery Info Subject to Change
Quote is Valid for a Period of 30 days from Issue Date
Matrox Items are Non-Refundable, Non-Returnable
Taxes and Shipping Costs are not quoted unless requested by Buyer

Item Total:	$104,437.84
Freight Estimate	0.00
Total Quote:	**$104,437.84**

PSI Solutions Incorporated
P.O. Box 24058, Federal Way WA 98093
Phone 253-838-9263, Fax 253-942-4700
Find Your Solution at www.psirep.com

Quote

12297

Date: 08/25/2008

Bill To:
University Of Washington
Accounts Payable
PO Box 351130
Seattle, WA 98105
USA

Please make your Purchase Order to:
PSI Solutions Incorporated
PO Box 24058
Federal Way, WA 98093

Ship to Attention: Michael Harrington

Please fax your Purchase Order to: 253-942-4700

REQ DATE: 08/25/2008
OUR REF#: 12297
PHONE: 206-543-6857
FAX#: 206-543-6785

TERMS: Net 30
FOB: Brea, CA
SALES PERSON: Greg Gohsman
509-674-2962

PSI Solutions Thanks You for the Opportunity to Provide this Quote

Item#	Part Number/Description	Qty	UM	Price	Total	Delivery
1	**EDS-510A-3GT** Moxa Managed Ethernet Switch with Three 10/100/1000 BaseTx and Seven 10/100 BaseTx Ports with VLAN,IGMP Snooping and QoS	1	EA	$ 1,471.08	$ 1,471.08	2 in Stock; Lead Time 2-4 Weeks ARO
2	**SFP-1GLXLC** Moxa SFP Interface Module with One 1000Lx Port, LC Connector 10Km Supported	1	EA	$ 440.68	$ 440.68	7 in Stock; Lead Time 2-4 Weeks ARO
3	**SFP-1GLHXLC** Moxa SFP Interface Module with One 1000LHx Port, LC Connector 40Km Supported	1	EA	$ 1,333.08	$ 1,333.08	6 in Stock; Lead Time 2-4 Weeks ARO
4	**WK-46** Moxa Wall Mount Kit for EDS Series	1	EA	$ 10.00	$ 10.00	50 in Stock
5	**EDS-510A-3GT** Moxa Managed Ethernet Switch with Three 10/100/1000 BaseTx and Seven 10/100 BaseTx Ports with VLAN,IGMP Snooping and QoS	10	EA	$ 1,407.12	$ 14,071.20	
6	**SFP-1GLXLC** Moxa SFP Interface Module with One 1000Lx Port, LC Connector 10Km Supported	10	EA	$ 421.52	$ 4,215.20	
7	**SFP-1GLHXLC** Moxa SFP Interface Module with One 1000LHx Port, LC Connector 40Km Supported	10	EA	$ 1,275.12	$ 12,751.20	

Price, Availability and Delivery Info Subject to Change
Quote is Valid for a Period of 30 days from Issue Date
Matrox Items are Non-Refundable, Non-Returnable
Taxes and Shipping Costs are not quoted unless requested by Buyer

Item Total:

Freight Estimate

Total Quote:

PSI Solutions Incorporated
P.O. Box 24058, Federal Way WA 98093
Phone 253-838-9263, Fax 253-942-4700
Find Your Solution at www.psirep.com

Quote

12297

Date: 08/25/2008

Bill To:
University Of Washington
Accounts Payable
PO Box 351130
Seattle, WA 98105
USA

Please make your Purchase Order to:
PSI Solutions Incorporated
PO Box 24058
Federal Way, WA 98093

Ship to Attention: Michael Harrington

Please fax your Purchase Order to: 253-942-4700

REQ DATE: 08/25/2008
OUR REF#: 12297
PHONE: 206-543-6857
FAX#: 206-543-6785

TERMS: Net 30
FOB: Brea, CA
SALES PERSON: Greg Gohsman
509-674-2962

PSI Solutions Thanks You for the Opportunity to Provide this Quote

Item#	Part Number/Description	Qty	UM	Price	Total	Delivery
8	**WK-46** Moxa Wall Mount Kit for EDS Series	10	EA	$ 10.00	$ 100.00	
9	**EDS-510A-3GT** Moxa Managed Ethernet Switch with Three 10/100/1000 BaseTx and Seven 10/100 BaseTx Ports with VLAN,IGMP Snooping and QoS	20	EA	$ 1,359.15	$ 27,183.00	
10	**SFP-1GLXLC** Moxa SFP Interface Module with One 1000Lx Port, LC Connector 10Km Supported	20	EA	$ 407.15	$ 8,143.00	
11	**SFP-1GLHXLC** Moxa SFP Interface Module with One 1000LHx Port, LC Connector 40Km Supported	20	EA	$ 1,231.65	$ 24,633.00	
12	**WK-46** Moxa Wall Mount Kit for EDS Series	20	EA	$ 10.00	$ 200.00	

Price, Availability and Delivery Info Subject to Change
Quote is Valid for a Period of 30 days from Issue Date
Matrox Items are Non-Refundable, Non-Returnable
Taxes and Shipping Costs are not quoted unless requested by Buyer

Item Total: $94,551.44

Freight Estimate 0.00

Total Quote: **$94,551.44**

EDS-510A Series

7+3G-port Gigabit managed Ethernet switch

> 2 Gigabit Ethernet ports for redundant ring and 1 Gigabit Ethernet port for uplink solution
> Turbo Ring (recovery time < 20 ms), RSTP/STP (IEEE 802.1w/D) for Ethernet redundancy
> QoS, IGMP snooping/GMRP, VLAN, LACP, SNMPv1/v2c/v3, RMON supported
> IEEE 802.1X, HTTPS, and SSH enhance network security
> ABC-01 (Automatic Backup Configurator) for system configuration backup

Introduction

The EDS-510A Gigabit managed redundant Ethernet switch is equipped with up to 3 Gigabit Ethernet ports, making it ideal for building a Gigabit Turbo Ring, but leaving a spare Gigabit port for uplink use. The Ethernet redundant Turbo Ring (recovery time < 20 ms) and RSTP/STP (IEEE 802.1w/D) can increase system reliability and the availability of your network backbone. The EDS-510A series is designed especially for communication demanding applications such as process control, shipbuilding, ITS, and DCS systems, which can benefit from a scalable backbone construction.

Features and Benefits

- Turbo Ring (recovery time < 20 ms at full load) and RSTP/STP (IEEE 802.1w/D)
- IGMP snooping and GMRP for filtering multicast traffic
- Port-based VLAN, IEEE 802.1Q VLAN, and GVRP to ease network planning
- QoS-IEEE 802.1p/1Q and TOS/DiffServ to increase determinism
- Port Trunking for optimum bandwidth utilization
- IEEE 802.1X, HTTPS, and SSH to enhance network security
- SNMPv1/v2c/v3 for different levels of network management
- RMON for efficient network monitoring and proactive capability
- Bandwidth management prevents unpredictable network status
- Lock port function for blocking unauthorized access based on MAC address
- Port mirroring for online debugging
- Automatic warning by exception through e-mail, relay output
- Digital inputs to integrate sensors and alarms with IP networks

Specifications

Technology

Standards: IEEE 802.3 for 10BaseT,
IEEE 802.3u for 100BaseT(X) and 100Base FX,
IEEE 802.3ab for 1000Base(X),
IEEE 802.3z for 1000BaseSX/LX/LHX/ZX,
IEEE 802.3x for Flow Control,
IEEE 802.1D for Spanning Tree Protocol,
IEEE 802.1w for Rapid STP,
IEEE 802.1Q for VLAN Tagging,
IEEE 802.1p for Class of Service,
IEEE 802.1X for Authentication,
IEEE 802.3ad for Port Trunk with LACP

Protocols: IGMPv1/v2 device, GMRP, GVRP, SNMPv1/v2c/v3, DHCP Server/Client, DHCP Option 82, BootP, TFTP, SNTP, SMTP, RARP, RMON, HTTP, HTTPS, Telnet, SSH, Syslog

MIB: MIB-II, Ethernet-Like MIB, P-BRIDGE MIB, Q-BRIDGE MIB, Bridge MIB, RSTP MIB, RMON MIB Group 1, 2, 3, 9

Flow Control: IEEE 802.3x flow control, back pressure flow control

Switch Properties

Priority Queues: 4

Max. Number of Available VLANs: 64

VLAN ID Range: VID 1 to 4094

IGMP Groups: 256

Interface

RJ45 Ports: 10/100BaseT(X) or 10/100/1000BaseT(X) auto negotiation speed

Fiber Ports: 1000BaseSFP slot

Console: RS-232 (RJ45)

LED Indicators: PWR1, PWR2, FAULT, 10/100M (TP port), 1000M (Gigabit port), MASTER, COUPLER

DIP Switch: Turbo Ring, Master, Coupler, Reserve

Alarm Contact: Two relay outputs with current carrying capacity of 1A @ 24 VDC

Digital Inputs: Two inputs with the same ground, but electrically isolated from the electronics.

- +13 to +30V for state "1"
- -30 to +3V for state "0"
- Max. input current: 8 mA

Power Requirements

Input Voltage: 24 VDC (12 to 45 VDC), redundant dual inputs
Input Current (@ 24 V): 0.65A (EDS-510A-3GT)
0.44A (EDS-510A-1GT2SFP)
0.46A (EDS-510A-3SFP)
Connection: Two removable 6-pin terminal blocks
Overload Current Protection: Present
Reverse Polarity Protection: Present

Physical Characteristics

Casing: IP30 protection, metal case
Dimensions (W x H x D): 80.2 x 135 x 105 mm (3.16 x 5.31 x 4.13 in.)
Weight: 1170 g
Installation: DIN-Rail mounting, wall mounting (optional kit)

Environmental Limits

Operating Temperature: 0 to 60°C (32 to 140°F)
-40 to 75°C (-40 to 167°F) for T models
Storage Temperature: -40 to 85°C (-40 to 185°F)
Ambient Relative Humidity: 5 to 95% (non-condensing)

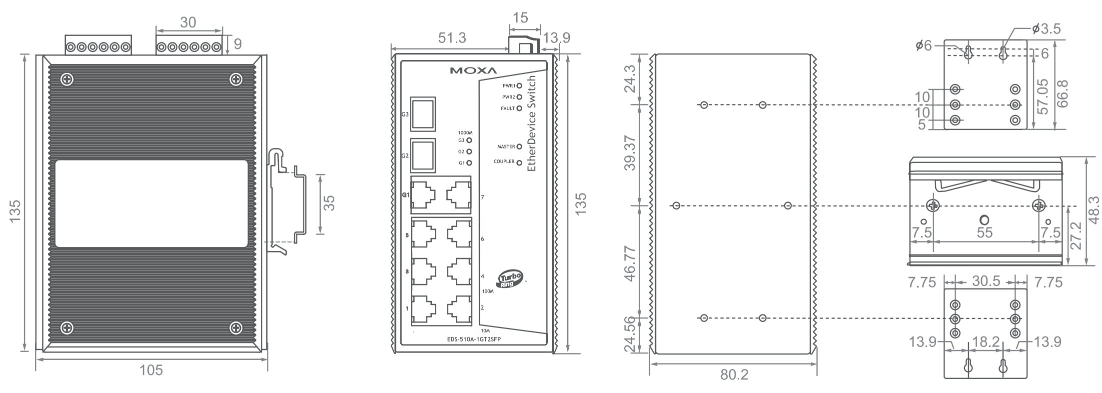
Regulatory Approvals

Safety: UL508, UL60950-1, CSA C22.2 No. 60950-1, EN60950-1
Hazardous Location:
UL/cUL Class I, Division 2, Groups A, B, C, and D;
ATEX Class I, Zone 2, Ex nC IIC (Pending)
Maritime: DNV, GL
EMI: FCC Part 15, CISPR (EN55022) class A
EMS: EN61000-4-2 (ESD), level 3
EN61000-4-3 (RS), level 3
EN61000-4-4 (EFT), level 3
EN61000-4-5 (Surge), level 2
EN61000-4-6 (CS), level 3
EN61000-4-8
EN61000-4-11
Shock: IEC 60068-2-27
Freefall: IEC 60068-2-32
Vibration: IEC 60068-2-6
MTBF: 204,000 hrs
Database: MIL-HDBK-217F, GB 25°C
*Please check Moxa's website for the most up-to-date certification status.

Warranty

5 years (see www.moxa.com/warranty for details)

Dimensions (unit = mm)



Side View DIN-Rail Kit Front View Rear View Mounting Kit

Ordering Information

Product Model		Port Interface		
		Gigabit Ethernet		Fast Ethernet
Standard Temperature (0 to 60°C)	Extended Temperature (-40 to 75°C)	10/100/1000BaseT(X)	1000BaseSFP*	10/100BaseT(X)
EDS-510A-3GT	EDS-510A-3GT-T	3		7
EDS-510A-1GT2SFP	EDS-510A-1GT2SFP-T	1	2	7
EDS-510A-3SFP	EDS-510A-3SFP-T		3	7

* EDS-510A series supports up to 3 1000BaseSFP slots. Please see page 2-23 for the product information of SFP-1G series Gigabit Ethernet SFP modules.

Optional Accessories

- **ABC-01:** Industrial RS-232, RJ45-based, automatic backup configurator
- **EDS-SNMP OPC Server Pro:** CD with EDS-SNMP OPC server software and manual
- **DR-4524:** 45W/2A DIN-Rail 24 VDC power supply, 85 to 264 VAC input
- **DR-75-24:** 75W/3.2A DIN-Rail 24 VDC power supply, 85 to 264 VAC input
- **DR-120-24:** 120W/5A DIN-Rail 24 VDC power supply, 88 to 132 VAC/176 to 264 VAC input by switch
- **WK-46:** Wall mounting kit
- **RK-4U:** 4U-high, 19" rack mounting kit

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00007**
For:	Digi Ports
Type:	Catalog
Date:	Nov 4, 2008
Company:	DigiConnect
Requested By:	Harrington

Notes:

Drop-in Networking
Embedded
Wireless
Remote Display
Connectivity
Console Servers
Cameras and Sensors
USB and Serial
Connectivity
Government Store
Show Specials
Accessories

View cart
Wishlist
My account
Search
Online store home

Digi Connect ME 9210 w/4 MB Flash, 8 MB SDRAM, with JTAG connector

Product #: DC-ME-Y402-JT
Our Price: $99.00

[Add to Wishlist]

Quantity: 1 Digi Connect ME 9210 w/4 MB Flash, 8 MB SDRAM, with JTAG connector Add to Cart

- Digi Connect ME 9210 w/4 MB Flash, 8 MB SDRAM, with JTAG connector

Wired Embedded Modules

back | next

Note: The Digi Online Store is currently set up for orders purchased and shipped in the United States and Canada ONLY. No International Orders can be filled at this time.

username

password

remember me

sign in register

password help

Digi Connect ME® 9210

Overview Specs Documentation

- Hardware
- Network Interface
- Environmental
- Power Requirements
- Regulatory Approvals
- Pinouts
- Dimensions
- Line Art

Hardware

- 32-bit Digi NS9210 processor @ 75 MHz (ARM926EJ-S)
- On-chip 256-bit AES accelerator
- Flexible Interface Modules (FIM)
  - 300 MHz DRPIC165X CPU
  - 2k program/192 bytes data RAM
- On-board memory
  - 2/4 MB NOR flash
  - 8 MB SDRAM
- High-speed TTL serial interface
  - Full signal support for TXD, RXD, RTS, CTS, DTR, DSR and DCD
  - Hardware/Software flow control
- Serial Peripheral Interface (SPI)
  - Master data rate up to 33.3 Mbps
  - Slave data rate up to 7.5 Mbps
- I^2C v1.0 bus interface
  - 7-bit and 10-bit address modes
- 10 shared GPIO ports with
  - Up to 3 external IRQ options
- Power management modes
  - On-the-fly clock scaling
  - Low power sleep modes
  - Configurable scaling/wake-up events (EIRQ, UART, Ethernet, etc.)
- Software watchdog
- On-board power supervisor
- Wave-solderable design
  - No clean flux process

Network Interface

- Physical layer: 10/100Base-T
- Data rate: 10/100 Mbps (auto-sensing)
- Mode: Full or half duplex (auto-sensing)
- Connector: RJ-45 w/magnetics
- 802.3af power pass-through
  - Mid- and end-span

Environmental

- Operating temperature:
  -40° C to +85° C (-40° F to +185° F)
- Storage temperature:
  -50° C to +125° C (-58° F to +257° F)
- Relative humidity:
  5% to 90% (non-condensing)
- Altitude: 12,000 feet (3,658 meters)

Power Requirements

- 3.3VDC @ 346 mA typical (1.14 W)
- UART and Ethernet activated
  Low Speed Idle mode (approx.)
- 3.3VDC @ 186 mA (613 mW)
- /16 clock scaling, Ethernet activated

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00009**
For:	DC DC Converters
Type:	Fixed Quote
Date:	Aug 18, 2008
Company:	Vicor
Requested By:	Harrington

Notes:

Headquarters: 25 Frontage Road, Andover, MA 01810
Tel (800) 735-6200 Fax (408) 774-5555
560 Oakmead Parkway, Sunnyvale, CA 94085-4022

University of Washington		Quotation No.	081808JP
Mike Harrington		Date	August 18, 2008
206-543-6857		Your Inquiry No.	
mikeh@apl.washington.edu		Sales Representative	Electra Tech Sls
		Tel. No.	425-985-8855
		Fax No.	425-821-7289

In response to your inquiry, we submit the following quotation:

Item	Qty.	Part Number	Unit Price	Estimated Delivery
1	1-24	V375A48C600BL	$309 ea	5 weeks ARO
2	1-24	V48B12C250BL	$168 ea	5 weeks ARO
3	1-24	V48B24C250BL	$168 ea	5 weeks ARO
4	1-24	V48B5C200BL	$149 ea	5 weeks ARO

TERMS	F.O.B.	
	Origin	

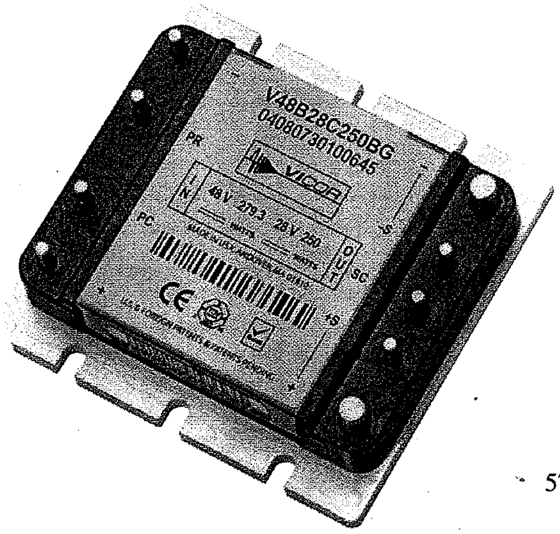
THIS QUOTATION IS VALID FOR 30 DAYS.

All orders are subject to Vicor's Terms & Conditions located at www.vicorpower.com/termsconditions/.

BY: Jacqueline Phillips, Sr. Customer Service Rep

Data Sheet
48V Input Mini Family
DC-DC Converter Module

RoHS



Shown actual size:
2.28 x 2.2 x 0.5 in
57,9 x 55,9 x 12,7 mm

Features
- RoHS Compliant (with F or G pin option)
- DC input range: 36 - 75 V
- Input surge withstand: 100 V for 100 ms
- DC output: 2 – 48 V
- Programmable output: 10 to 110%
- Regulation: ±0.2% no load to full load
- Efficiency: Up to 89%
- Maximum operating temp: 100°C, full load
- Power density: up to 100 W per cubic inch
- Height above board: 0.43 in. (10,9 mm)
- Parallelable, with N+M fault tolerance
- Low noise ZCS/ZVS architecture

Product Overview
These DC-DC converter modules use advanced power processing, control and packaging technologies to provide the performance, flexibility, reliability and cost effectiveness of a mature power component. High frequency ZCS/ZVS switching provides high power density with low noise and high efficiency.

Applications
Distributed power, medical, ATE, communications, defense, aerospace

Absolute Maximum Ratings

Parameter	Rating	Unit	Notes
+In to –In voltage	-0.5 to +105	Vdc	
PC to –In voltage	-0.5 to +7.0	Vdc	
PR to –In voltage	-0.5 to +7.0	Vdc	
SC to –Out voltage	-0.5 to +1.5	Vdc	
–Sense to –Out voltage	1.0	Vdc	
Isolation voltage			
in to out	3000	Vrms	Test voltage
in to base	1500	Vrms	Test voltage
out to base	500	Vrms	Test voltage
Operating Temperature	-55 to +100	°C	M-Grade
Storage Temperature	-65 to +125	°C	M-Grade
Pin soldering temperature	500 (260)	°F (°C)	<5 sec; wave solder
	750 (390)	°F (°C)	<7 sec; hand solder
Mounting torque	5 (0.57)	in-lbs (N-m)	6 each

Part Numbering
e.g. V48B12T250BL2

V48B ☐ ☐ ☐ **B** ☐ ☐

Output Voltage

2 = 2 V	
3 V 3 = 3.3 V	
5 = 5 V	
12 = 12 V	
15 = 15 V	
24 = 24 V	
28 = 28 V	
36 = 36 V	
48 = 48 V	

Product Grade Temperatures (°C)

Grade	Operating	Storage
E =	– 10 to +100	– 20 to +125
C =	– 20 to +100	– 40 to +125
T =	– 40 to +100	– 40 to +125
H =	– 40 to +100	– 55 to +125
M =	– 55 to +100	– 65 to +125

Output Power

Vout	Pout
2 V	**100 W**
3.3 V	**150 W**
5 V	**200W**
12 V	**250 W**
15 V	**250 W**
24 V	**250 W**
28 V	**250 W**
36 V	**250 W**
48 V	**250 W**

Pin Style
- **Blank:** Short Tin/Lead
- **L:** Long Tin/Lead
- **S:** Short ModuMate
- **N:** Long ModuMate
- **F:** Short RoHS
- **G:** Long RoHS

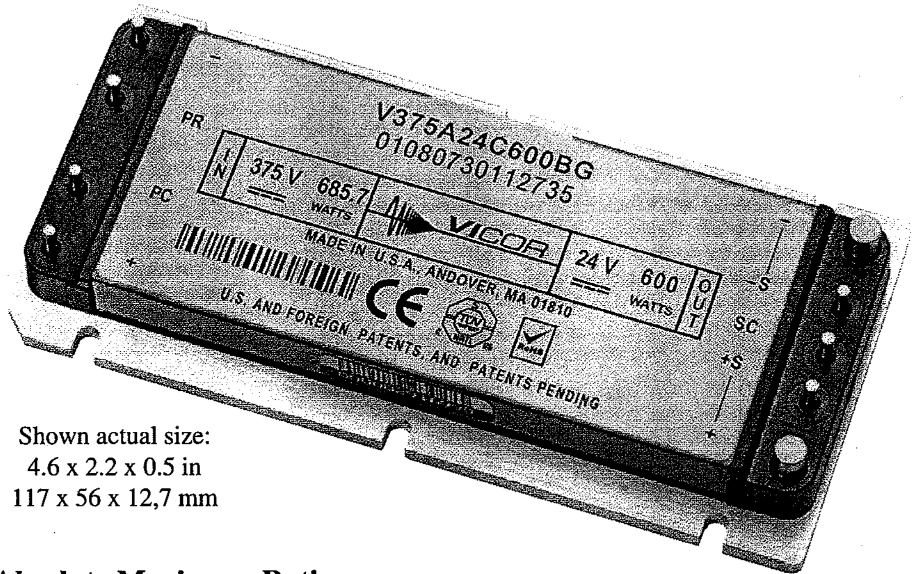
Baseplate
- **Blank:** Slotted
- **2:** Threaded
- **3:** Through-hole

For a description of pin options, see page 9.
Baseplate options include slotted flanges, threaded and through-hole.
See page 10 for dimensions.
For other package sizes and power levels, see the Micro (quarter size) and Maxi (full size) datasheets.

![VICOR]

Data Sheet
375V Input Maxi Family
DC-DC Converter Module

RoHS



Shown actual size:
4.6 x 2.2 x 0.5 in
117 x 56 x 12,7 mm

Features

- RoHS Compliant (with F or G pin option)
- DC input range: 250 – 425 V
- Input surge withstand: 500 V for 100 ms
- DC output: 2 – 54 V
- Programmable output: 10 to 110%
- Regulation: ±0.25% no load to full load
- Efficiency: Up to 89%
- Maximum operating temp: 100°C, full load
- Power density: up to 120 W per cubic inch
- Height above board: 0.43 in. (10,9 mm)
- Parallelable, with N+M fault tolerance
- Low noise ZCS/ZVS architecture

Product Overview

These DC-DC converter modules use advanced power processing, control and packaging technologies to provide the performance, flexibility, reliability and cost effectiveness of a mature power component. High frequency ZCS/ZVS switching provides high power density with low noise and high efficiency.

Applications

Off-line systems with PFC front ends, industrial and process control, distributed power, medical, ATE, communications, defense, aerospace

Absolute Maximum Ratings

Parameter	Rating	Unit	Notes
+In to –In voltage	-0.5 to +525	Vdc	
PC to –In voltage	-0.5 to +7.0	Vdc	
PR to –In voltage	-0.5 to +7.0	Vdc	
SC to -Out voltage	-0.5 to +1.5	Vdc	
-Sense to -Out voltage	1.0	Vdc	
Isolation voltage			
in to out	3000	Vrms	Test voltage
in to base	1500	Vrms	Test voltage
out to base	500	Vrms	Test voltage
Operating Temperature	-55 to +100	°C	M-Grade
Storage Temperature	-65 to +125	°C	M-Grade
Pin soldering temperature	500 (260)	°F (°C)	<5 sec; wave solder
	750 (390)	°F (°C)	<7 sec; hand solder
Mounting torque	5 (0.57)	in-lbs (N-m)	6 each

Part Numbering

e.g. V375A12T600BL2

V375A ☐ ☐ ☐ **B** ☐ ☐

Output Voltage
2 = 2 V
3V3 = 3.3 V
5 = 5 V
8 = 8 V
12 = 12 V
15 = 15 V
24 = 24 V
28 = 28 V
32 = 32 V
36 = 36 V
48 = 48 V
54 = 54 V

Product Grade Temperatures (°C)

Grade	Operating	Storage
E =	– 10 to +100	– 20 to +125
C =	– 20 to +100	– 40 to +125
T =	– 40 to +100	– 40 to +125
H =	– 40 to +100	– 55 to +125
M =	– 55 to +100	– 65 to +125

Output Power

Vout	Pout
2 V	160 W
3.3 V	264 W, 200 W
5 V	300 W, 400 W
8 V	400 W
12 V	400 W, 600 W
15 V	400 W, 600 W
24 V	400 W, 600 W
28 V	400 W, 600 W
32 V	600 W
36 V	400 W, 600 W
48 V	400 W, 600 W
54 V	600 W

Pin Style
Blank: Short Tin/Lead
L: Long Tin/Lead
S: Short ModuMate
N: Long ModuMate
F: Short RoHS
G: Long RoHS

Baseplate
Blank: Slotted
2: Threaded
3: Through-hole

For a description of pin options, see page 12. Baseplate options include slotted flanges, threaded and through-hole. See page 13 for dimensions. For other package sizes and power levels, see the Mini (half size) and Micro (quarter size) data sheets.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00010**
For:	Solid State DC Switch
Type:	Web
Date:	11/4/08
Company:	Digikey
Requested By:	Harrington

Notes:

crydom™

Series SSC
Solid State DC Contactor
25Amp • 0-1000 Vdc - DC OUTPUT

- **IGBT Output**
- **Panel Mount**
- **High Voltage**
- **Internal Overvoltage Protection Available**
- **Control Voltage 12Vdc, 24Vdc, 36Vdc**

Series SSC solid state DC contactors feature IGBT technology for high voltage DC switching applications All models come in Crydom's standard panel-mount package. Manufactured in Crydom's ISO 9001 Certified facility for optium product performance and reliability.

OUTPUT SPECIFICATIONS ①

MODEL NUMBERS	**SSC800-25**	**SSC1000-25**
Operating Voltage Range [Vdc]	0-800	0-1000
Maximun Transient Voltage [Vpk]	900 ④	1200 ⑤
Max. Load Current ③ [Adc]	25	25
Min. Load Current [mA]	20	20
Max. Surge Current, [Adc] (10msec)	75	75
Max. On-State Voltage Drop @ Rated Current [Vdc]	1.6	1.6
Thermal Resistance Junction to Case [$R_{\theta JC}$] C/W	0.8	0.8
Max. Off-State Leakage Current @ Rated Voltage [mA]	0.3	0.3
Max. Turn-On Time [msec]	1.5	1.5
Max. Turn-Off Time [msec]	1.5	1.5

INPUT SPECIFICATIONS ①

Nominal Control Voltage [Vdc] ⑥	12	24	36
Control Voltage Range [Vdc]	8-16	20-28	32-40
Maximum Turn-On Voltage [Vdc]	8	20	32
Minimum Turn-Off Voltage [Vdc]	1	1	1
Nominal Input Impedance [Ohm]	780	1500	2,400
Typical Input Current at Nominal Voltage [mA]	15	15	15

GENERAL NOTES

① All parameters at 25ºC unless otherwise specified.
② Dielectric strength and insulation resistance are measured between input and output.
③ Heat sinking required, for derating curves see page 2.
④ Internal overvoltage protection included.
⑤ Internal overvoltage protection not included.
⑥ Use suffix -12, -24 or -36 to specify control voltage. For other values call factory
Sample: **SSC800-25-24.**

For recommended applications and more information contact:
USA: Sales Support (877) 502-5500 **Tech Support** (877) 702-7700 FAX (619) 710-8540
Crydom Inc., 2320 Paseo de las Americas, Ste. 201, San Diego, CA 92154
Email: sales@crydom.com **WEB SITE:** http://www.crydom.com
UK: +44 (0)1202 606030 • **FAX** +44 (0)1202 606035 Crydom SSR Ltd., Arena Business Centre, Holyrood Close, Poole, Dorset BH17 7FJ, Email: intsales@crydom.com.
GERMANY: +49 (0)180 3000 506

ISO 9001 CERTIFIED

Series SSC
Solid State DC Contactor
25Amp • 0-1000 Vdc - DC OUTPUT

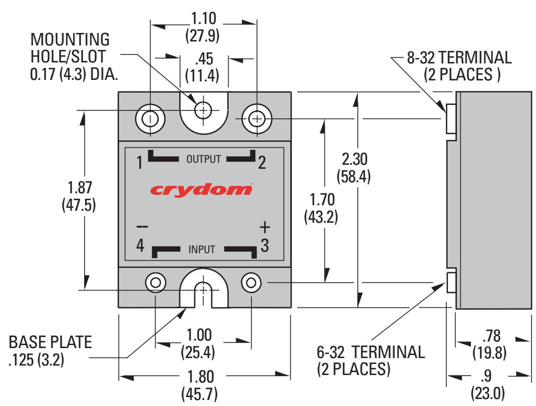
GENERAL SPECIFICATIONS

Dielectric Strength 60Hz	2500 Vrms
Insulation Resistance (Min.) @ 500 Vdc	10^9 Ohm
Max. Capacitance Input/Output	50 pF
Ambient Operating Temperature Range	-30 to 80ºC
Ambient Storage Temperature Range	-40 to 125ºC

MECHANICAL SPECIFICATIONS

Weight: (typical)	3.0 oz. (86.5g)
Encapsulation:	Thermally Conductive Epoxy
Terminals:	Screws and Saddle Clamps Furnished, Unmounted

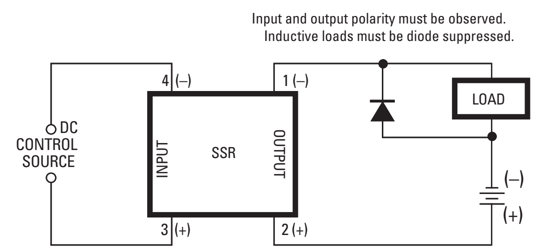
MECHANICAL SPECIFICATIONS



Screw Torque Requirements:

6-32 Screws - 10 in. lbs. (1.1 Nm),
8-32 - 20in. lbs. (2.2 Nm) (Screws dry without grease.)

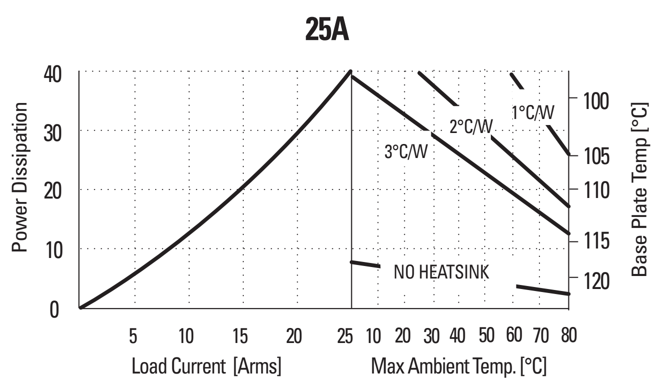
WIRING CONNECTIONS



Transient Protection

All loads are inductive, even ones that are not so labeled. An inductive load will produce harmful transient voltages when it is turned off. The more perfect the switch, the larger the transient voltages; the IGBT output is so nearly an ideal switch that the transient voltages produced by seemingly "non-inductive" loads can cause damage if not suppressed. Diodes should be fast recovery type with PIV rated greater than supply voltage.

CURENT DERATING CURVE



For recommended applications and more information contact:
USA: Sales Support (877) 502-5500 **Tech Support** (877) 702-7700 FAX (619) 710-8540
Crydom Inc., 2320 Paseo de las Americas, Ste. 201, San Diego, CA 92154
Email: sales@crydom.com **WEB SITE:** http://www.crydom.com
UK: +44 (0)1202 606030 • **FAX** +44 (0)1202 606035 Crydom SSR Ltd., Arena Business Centre, Holyrood Close, Poole, Dorset BH17 7FJ, Email: intsales@crydom.com.
GERMANY: +49 (0)180 3000 506

⚠ DANGER / PELIGRO / DANGER /GEFAHR / PERICOLO / PERIGO

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH.	RIESGO DE DESCARGA ELECTRICA O EXPLOSION.	RISQUE DE DESCHARGE ELECTRIQUE OU EXPLOSION	GEFAHR EINES ELEKTRISCHEN SCHLAGES ODER EINER EXPLOSION.	RISCHIO DI SCOSSA ELETTRICA O DELL'ESPLOSIONE.	RISCO DE DESCARGA ELÉTTRICA OU EXPLOSÃO
• Disconnect all power before installing or working with this equipment. • Verify all connections and replace all covers before turning on power. **Failure to follow these instructions will result in death or serious injury.**	• Desconectar todos los suministros de energia a este equipo antes de trabajar con este equipo. • Verificar todas las conexiones y colocar todas las tapas antes de energizer el equipo. **El incumplimiento de estas instrucciones puede provocar la muerte o lesiones serias.**	• Eteindre toutes les sources d'énergie de cet appareil avant de travailler dessus de cet appareil • Vérifier tous connections, et remettre tous couverts en olace avant de mettre sous **De non-suivi de ces instructions provoquera la mort ou des lésions sérieuses sérieuses.**	• Stellen Sie jeglichen Strom ab, der dieses Gerät versorgt, bevor Sie an dem Gerät Arbeiten durchführen • Vor dem Drehen auf Energie alle Anschlüsse überprüfen und alle Abdeckungen ersetzen. **Unterlassung dieser Anweisungen können zum Tode oder zu schweren Verletzungen führen.**	• Spenga tutta l'alimentazione che fornisce questa apparecchiatura prima del lavorare a questa apparecchiatu ra • Verificare tutti i collegamenti e sostituire tutte le coperture prima della rotazione sull'alimentazi one **L'omissione di seguire queste istruz ioni provocherà la morte o di lesioni serie**	• Desconectar o equipamento de toda á energia antes de instalar ou trabalhar com este equipamento • Verificar todas as conexões e recolocar todas as tampas antes de religar o equipamento **O não cumprimento destas instruções pode levar á morte ou lesões sérias.**

⚠ WARNING / AVERTISSEMENT / WARNUNG /ADVERTENCIA / AVVERTENZA / AVISO

RISK OF MATERIAL DAMAGE AND HOT ENCLOSURE • The product's side panels may be hot, allow time for product to cool before touching. • Follow proper mounting instructions including torque values. • Do not allow liquids or foreign objects to enter this product. **Failure to follow this instruction can result in serious injury, or equipment damage.**	**RISQUE DE DOMMAGE MATERIEL ET DE SURCHAUFFE DU BOITIER** • Les panneaux latéraux du produit peuvent être chauds. Laisser le produit refroidir avant de le toucher. • Respecter les consignes de montage, et notamment les couples de serrage. • Ne pas laisser pénétrer de liquide ni de corps étrangers à l'intérieur du produit. **Le non-respect de cette directive peut entraîner, des lésions corporelles graves ou des dommages matériels.**	**GEFAHR VON MATERIALSCHÄDEN UND GEHÄUSEERHITZUNG** • Die Seitenwände können heiß sein. Lassen Sie das Produkt abkühlen, bevor Sie es berühren. • Beachten Sie die Montageanweisungen, • Führen Sie keine Flüssigkeiten oder Fremdkörper in das Produkt ein. **Die Nichtbeachtung dieser Anweisung kann Körperverletzung oder Materialschäden zur Folge haben.**
RIESGO DE DAÑOS MATERIALES Y DE SOBRECALENTAMIENTO DE LA UNIDAD • Los paneles laterales del producto pueden estar calientes. Esperar que el producto se enfríe antes de tocarlo. • Respetar las instrucciones de montaje, y en particular los pares de apretado. • No dejar que penetren líquidos o cuerpos extraños en el producto. **Si no se respetan estas precauciones pueden producirse graves lesiones, daños materiales.**	**RISCHIO DI DANNI MATERIALI E D'INVOLUCRO CALDO** • I pannelli laterali dell'apparecchio possono scottare; lasciar quindi raffreddare il prodotto prima di toccarlo. • Seguire le istruzioni di montaggio corrette. • Non far entrare liquidi o oggetti estranei in questo apparecchio. **La mancata osservanza di questa precauzione può causare gravi rischi per l'incolumità personale o danni alle apparecchiature.**	**RISCO DE DANO MATERIAL E DE AQUECIMENTO** • Os painéis laterais do produto podem estar quentes; dê tempo ao produto para arrefecer antes de lhe tocar. • Siga devidamente as instruções de montagem. • Não permita a entrada de líquidos e de objectos estranhos no produto. **A não observância destas precauções pode provocar a morte, ferimentos graves ou danos materiais.**

ANNEX – ENVIRONMENTAL INFORMATION:

The environmental information disclosed in this annex including the EIP Pollution logo are in compliance with People's Republic of China Electronic Industry Standard SJ/T11364 – 2006, Marking for Control of Pollution Caused by Electronic Information Products.

Part Name	Toxic or hazardous Substance and Elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr (VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
Semiconductor die	X	O	O	O	O	O
Solder	X	O	O	O	O	O

附件 - 环保信息:

此附件所标示的包括电子信息产品污染图标的环保信息
符合中华人民共和国电子行业标准 **SJ/T11364 - 2006,**
电子信息产品污染控制标识要求

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
半导体芯片	X	O	O	O	O	O
焊接点	X	O	O	O	O	O

Keywords:

- [ ] **In Stock**
- [ ] **Lead free**
- [ ] **RoHS compliant**

Search Again

Digi-Key Part Number	SSC800-25-36-ND
Quantity Available	0 Enter Quantity Requested
Manufacturer	Crydom Co.
Manufacturer Part Number	SSC800-25-36
Description	CONTACTOR DC SSR 25A 800VDC 36V
Lead Free Status / RoHS Status	Lead free / RoHS compliant
All prices are in US dollars.	

Price Break	Unit Price	Extended Price
1	158.87000	158.87

Photo Not Available

Non-Stock

Quantity	Item Number	Customer Reference	
	SSC800-25-36-ND		Add to Order

When requested quantity exceeds displayed pricing table quantities, a lesser unit price may appear on your order.
You may submit a request for quotation on quantities which are greater than those displayed in the pricing table.

Datasheets	SSC Series
Standard Package	1
Category	Relays
Family	Solid State
Series	SSC
Mounting Type	Chassis Mount
Termination Style	Screw Terminal
Package / Case	PUK
Circuit	SPST-NO (1 Form A)
Load Current	25A
Voltage - Input	32 ~ 40VDC
Voltage - Load	0 ~ 800V
Output Type	DC
On-State Resistance	-
Other Names	SSC800-25-36 SSC800-25-36-ND

Send this link via E-Mail

21:39:07 11/5/2008 - Help With This Screen

701 Brooks Avenue South, Thief River Falls, MN 56701 USA

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00012**
For:	Pressure Housings
Type:	Phone Quote
Date:	Aug 1, 2007
Company:	Various
Requested By:	Strenge

Notes:

Neptune metals summary $$$$$$$$ 7/1/07

Titanium sphere. [Wah Chang, Mike Wilcox]
The titanium spheres like MBARI had made are about .312 thick and **14.5 inch** internal diameter. The cost is about 12k for the sphere (made up of 2 halves) He felt they could make a sphere up to 30 inch [he furnace is 48 x 60 x 60 inch high.]

Sphere:		12,000
Machining: 10 hr each ($1000)		2000
	Total	**$14,000**

Internal volume ~ 1 cu ft $14,000/ cu ft

Titanium cast housing Wah Chang [mike Wilcox] estimated a **16 inch ID** housing 1 inch wall thickness and 30 inches long would cost $16,510 this includes chemical and mechanical test reports and Hot Isostatic Pressing of the casting. [Grade 5] The casting weighs about 260 lbs. This is a cost of $64/lb
(The first casting would be $18,585 with a one time pattern cost of $4660)

Housing:		17000
Machining: [30 hr] $3000		3000
End caps: 18 dia /2.5 thick/131 lbs, ~$50/lb ~~$6500		13000
Machining: 40 hrs each $4000 each		8000
	Total	**$41,000**

Internal volume ~ 3.2 cu ft ~ $12800/ cu ft

Titanium Pipe: Tico Titanium (Lynn Brace) quoted 8 inch Sch 80 (8.6255 OD ½ inch wall) at $1980 in 20 foot lengths. This is 24.8 lb/foot or $80 per lb.
She said they could get extruded pipe up to 10 inch and schedule 160. [10.75 OD 1.125 wall]

Pipe (30 inch long)	10.75 OD/ .593 wall/8.91 ID	5000
Machine	15 hrs	1500
End caps	1.5 thick 28 lb $50/lb 2 ea	2800
Machine	20 hrs each	4000
	Total	**$13,000**

Internal volume ~ 1 cu ft $13,000/cu ft

Beryllium Copper The main player is Brush Wellman Company. Donald Moracz (sp) said they make housings 10.2 ID every day (repeater housing?) and frequently 14.8 ID. He said they could go up to 16 ID, but the length would be critical. The 10.2 ID x ~27 is about $6000, tube fully machined. You would still need end caps. The 14.8 ID by ~28 inches is about $20k. You still need end caps. Both will go to the deepest part of the ocean

10.2 ID ~ 14 od		$6000
End caps 2 inch thick 70 lb at $40/lb		$5600
Machine end caps 40 hrs total		$4000
	Total	**$15600**

Total volume ~~ 1.3 cu ft ~ $12,200/cu ft

14.8 ID by ~18 OD by 28 inches	$20,000
End caps 2 inch thick 154 lbs ea @$40/lb	$12300
Machine enc caps 40 hrs total	$4000
Total	**$36,000**
Internal volume ~~2.7 cu ft $13,000/cu ft	

Aluminum Readily available in almost infinite sizes and wall thickness. $5 to $10/ lb. Corrosion is the killer here. For short time use it may be OK.

Winch information:

The winch would raise and lower an oceanographic instrument package containing numerous scientific instruments. The package would be about 50 kg positively buoyant. The winch will be set at 200 meters depth in salt water. Maximum cable speed about 0.5 meters/second. Cable diameter about 1 cm. Power, available at 400 volts DC or any voltage reduced down from 400 VDC. Life under water 1 year min to 5 years max. Do not include slip rings in the cost.

A British Company, All Oceans estimated the winch at $60k.

Inter Ocean (San Diego Ca) estimated the winch at 75 to 100K based on one they make now. The main problems he indicated would be marine growth and silting.

Falco, a Canadian company makes fiber optic slip ring assemblies, that can be packaged in under water housings. No $ est.

From looking at pictures of the Inter Ocean winch, I think it could be made for 30k after the design is done. The FO slip ring is a big unknown.

RELATIVE MATERIAL PROPERTIES

MATERIAL	~RELATIVE COST	~CORROSION SUSEPTABILITY	~DENSITY LB/CU. FT.	~CONDUCTIVITY BTU/(HR FT F)	~YIELD STRENGTH KSI
STEEL	1	HIGH	500	28	30-70
ALUMINUM 6061-T6	5	HIGH	165	120	40
STAINLESS STEEL	10	MED -LOW	500	10	35-130
BERYLLIUM COPPER ALLOY165	35	VERY LOW-NIL	525	60	150
TITANIUM GRADE 5	40-70	VERY LOW-NIL	280	4	120

The materials used for long term deep ocean pressure housings are mainly Stainless Steel, Beryllium Copper and Titanium. Steel and Aluminum are too susceptible to corrosion for long term deployment.

Stainless Steel

The common commercial grades of stainless steel, 17-4PH and 316 are available in tube and plate form for under sea pressure housings. They provide high resistance to sea water attack, but for long term submergence 316 can be subject to pit and or crevice corrosion. The surfaces should be machined smooth with out crevices. Crevices allow chlorides to concentrate and lead to corrosion. For strength considerations 316 has a yield of 30 ksi, with 17-4PH on the high end with130 ksi. These stainless steels can be machined and welded. 17-4PH has been used by APL and Benthos for deep sea housings.

Beryllium Copper.

Beryllium copper alloy 165 has been used extensively for deep sea housings on the trans-ocean cables. It is almost impervious to corrosion and has been used as deep sea repeater housings for 30 + years with out evidence of fouling or detrimental corrosion. They have been removed, refurbished and reused. The yield strength is 150 ksi in alloy 165 used for housings. The housing usually starts as a billet that can be machined or forged into a ring or "pipe". The finish shape is then machined. Special tube shape can be extruded but at a high cost for short runs. Be-Cu is readily machined and with care can be welded. Other beryllium copper alloys are available in some flat and tube shapes.
Brush Wellman is the main supplier of alloy 165 from mining to finished product and has done extensive work on the fabrication of the repeater housings.

Titanium

Titanium is offered in more than 30 ASTM alloy grades, with varying properties, but grades 2 (pure TI) and grade 5 (TI-6A1-4V) are the most commercially available. They are available in the form of bar, plates and pipe. It can be formed by casting, rolling, forging and conventional machining. It machines similar to stainless steels. In the unalloyed condition its strength is strong as steel but 45% lighter. Its resistance to corrosion in seawater is excellent, and almost as good as platinum. It has a fairly low electrical and thermal conductivity.
Grade 5 titanium was used by MBARI to make 18 inch diameter cast seismometer housings, for burial in the ocean at 4000 meters. It was selected for its strength, resistance to corrosion and harmful microbes. They worked closely with Allegheny Technologies to develop the process.
The AMM project used both Titanium and Beryllium Copper pressure housings.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00030**
For:	RAS
Type:	Budgetary Quote / email
Date:	22 July 2008
Company:	McLane Research Labs
Requested By:	SD, DSK

Notes: RAS + alterations
.

From: Alison Sargent [asargent@mclanelabs.com]
Sent: Tuesday, July 22, 2008 9:19 AM
To: denny@apl.washington.edu
Subject: 2008-AS-138-RAS and PPS Quote

Skip,

The RAS-500 currently costs $32,800 and the RAS-100 cost $29,800.
Budgetary pricing for the PPS is currently $24,930.

The RAS-500 collects up to 48 500ml samples, the RAS-100 collects up to 48 100ml samples and the PPS collects up to 24 filtered samples.

I hope this information is helpful. Please let me know if I can help further.

Regards,
Alison

Alison Sargent
McLane Research Laboratories, Inc.
Falmouth Technology Park
121 Bernard Saint Jean Drive
East Falmouth, MA 02536 USA

phone: +1 508 495 4000
fax: +1 508 495 3333
www.mclanelabs.com <http://www.mclanelabs.com>

-----Original Message-----
From: mclane@shark.ahoy.com [mailto:mclane@shark.ahoy.com]
Sent: Thursday, July 17, 2008 5:00 PM
To: mclane@mclanelabs.com
Subject: McLane Research Labs Contact Form

The following contact sent this message
as a response to the McLane Research Labs Contact Form

First Name: Skip
Last Name: Denny
Company: APL-U. Washington
Address 1: 1013 NE 40th St.
Address 2: Mail Stop 355640
City: Seattle
State: Washington
Zip: 98105-6698
Phone: 206 543-8042
Fax:
Email: denny@apl.washington.edu

Comments:
The OOI-RSN system has another design review and we need an updated cost estimate for RAS and PPS (maximum number of samples).

RAS-PPS
Date: Mon, 08 Oct 2007 09:14:24 -0700
From: Dave Butterfield <David.A.Butterfield@noaa.gov>
To: dskelley@u.washington.edu
Subject: Re: RAS and PPS

Hi Deb,

I would say as ballpark numbers those are probably ok. The breakdown would be something like this:

RAS off the shelf $35,000
Add temperature sensors $5000
Add sulfide sensor $6000
Add pH sensor $6000
Controlling software/electronics/pressure case $15,000
Frame, mooring, hardware $6000
Adds up to $73,000 per RAS

PPS off the shelf $24,000
Controlling software/electronics/pressure case $15,000
Frame, mooring, hardware $6000
Adds up to $45,000 per PPS

Underwater mateable connectors would increase the cost to connect to the node.

I can come and meet you this afternoon. I have a meeting at APL at 2, so that probably doesn't leave enough time for lunch after the MGG seminar. The meeting could go on for 2 hours or so, and I could come and find you afterward if you are free. Where will you be?

Cheers,
Dave

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00031**
For:	PPS
Type:	Budgetary Quote / email
Date:	22 July 2008
Company:	McLane Research Labs
Requested By:	SD, DSK

Notes: PPS + alterations
.

From: Alison Sargent [asargent@mclanelabs.com]
Sent: Tuesday, July 22, 2008 9:19 AM
To: denny@apl.washington.edu
Subject: 2008-AS-138-RAS and PPS Quote

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I hope this information is helpful. Please let me know if I can help further.

Regards,
Alison

Alison Sargent
McLane Research Laboratories, Inc.
Falmouth Technology Park
121 Bernard Saint Jean Drive
East Falmouth, MA 02536 USA

phone: +1 508 495 4000
fax: +1 508 495 3333
www.mclanelabs.com <http://www.mclanelabs.com>

-----Original Message-----
From: mclane@shark.ahoy.com [mailto:mclane@shark.ahoy.com]
Sent: Thursday, July 17, 2008 5:00 PM
To: mclane@mclanelabs.com
Subject: McLane Research Labs Contact Form

The following contact sent this message
as a response to the McLane Research Labs Contact Form

First Name: Skip
Last Name: Denny
Company: APL-U. Washington
Address 1: 1013 NE 40th St.
Address 2: Mail Stop 355640
City: Seattle
State: Washington
Zip: 98105-6698
Phone: 206 543-8042
Fax:
Email: denny@apl.washington.edu

Comments:
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Cheers,
Dave

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00032**
For:	Broadband Hydrophone
Type:	Budgetary Quote / Email
Date:	28 December 2007
Company:	Naxys-Bjorge
Requested By:	SD

Notes: For beaked whales, need frequencies to 150 kHz max.
Will probably need better sensitivity for seismic work.

From: Rune Århus [rune.arhus@bjorge.no]
Sent: Friday, December 28, 2007 1:04 AM
To: Skip Denny
Cc: elend@ocean.washington.edu; Jens Abrahamsen; Håkon Eirik Holm
Subject: SV: information

Attachments: Gerald (Skip) Denny (Denny@apl.washington.edu).vcf; Datasheet EH1.pdf

Hi Gerald,

Here at Naxyx-Bjorge, we are in the final part of the upgrading project, for the Ethernet Naxyx Hydrophone. And we have started a production of 10 units since the hardware modifications are set. Please have a look at the PRELIMINARY (!) datasheet attached. The new user friendly software is the most signifiicant part of this upgrading.

I presume the first Hydrophone's are ready for sale in February. Than, in February, I have started making plans of traveling to US for a hydrophone presentation, and possibly to visit your University. Would that be interesting, to let me do a product presentation at your site? Please let me know, how you consider that.

In October-07, I was e.mailed from Mitch Elend also at University of Washington, about more information on the Ethernet hyd. He is copied in this reply, since it is conveniate to also update him on our progress in this project.

Other inputs;
- price will be 52000,- NOK(Norwegian Kroner), or about 9793,- USD
- depth specification is 3000m
- A Burton cable connector and 10m Cat5 with power pair, is included in the price.(this connector and cable is qualified for 100m data transmission, and also to take the 3000m depth spec without effecting the capasitance in the cable)

Finally I whish you both A Happy New Year ! , and challanging and interesting scientific project to come in 2008.

With best regards from

Rune Aarhus
Sales Engineer
Bjorge, Division Metering and Subsea Monitoring
Tel office +47 55 36 48 90, mobile +47 930 87 199
Fax +47 55 36 48 81

Fra: Skip Denny [mailto:denny@apl.washington.edu]
Sendt: 26. desember 2007 19:01

Til: naxys-sales@bjorge.no
Emne: information

Hei,

Could you please send me information on the Ethernet hydrophones (particularly frequency response, power consumption, input power)? I'm working on the engineer for the cabled observatory (NSF-OOI/RSN) project – instrumenting the Juan de Fuca tectonic plate off the coast of Oregon and Washington states in the US. Your instrument was given as a representative one for several applications in the system.

Hilsen,

Skip Denny

Senior Engineer

206 543-8042

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00033**
For:	Digital Still Camera
Type:	Budgetary Quote / phone
Date:	29 September 2008
Company:	Prosilica
Requested By:	SD

Notes: GE-2040C in book – needs Pan and Tilt (ROS) + lights
(ROS LEDs, or HIDs)
Earlier quotes included.

From: Skip Denny [denny@apl.washington.edu]
Sent: Monday, September 29, 2008 11:12 AM
To: 'Deborah kelley'
Subject: Prosilica quote (phone)

Hi Deb,

To document call: notes from David Frosini/Prosilica this AM:

Kodak (GE series) has larger format/CCD ~= Sony standard format

Sony Exview HAD (models -1380, -660, -1290) have popular 2/3” optic CCD and high sensitivity and dynamic range – he recommends GC1380C for our application.

Bandwidth: 124 MB/s (1GigE) – color can be interpreted on shore so only send 8-12 bit/pixel OR done in camera and shipped at 24-bit/pixel – engineering decision.

Optical transducer: CCD much better than CMOS (low sensitivity & noisy).

Color prices same as B/W

No pan/tilt, no housing, all cameras need lenses (add ~$200 to $1,000 each)

Prices:

Model	Price	Comments
-2040	$7,790	f-mount lens needed
-2040	$7,590	c-mount lens needed
-1050	$4,790	1K x 1K pixel
-1380	$3,190	Exview HAD, 20 fps
-1388	$3,490	Exview HAD, 30 fps
-2450	$4,290	5 Mpix std, 2/3” CCD, wants high MPF lens
-1600	$2,490	1600x1200 pixels, non-Exview
-1350	$1,890	½” CCD, non-Exview

Skip Denny

Senior Engineer

206 543-8042

From: Tim McGinnis [tmcginnis@apl.washington.edu]
Sent: Wednesday, November 07, 2007 1:02 PM
To: dskelley@u.washington.edu
Cc: harkins@apl.washington.edu; mikeh@apl.washington.edu
Subject: RE: GE2040 Camera - Quotation Q070460 attached (fwd)

Would the plan be to stream images or take snap shots? I assume that we would need continuous vs. strove lights.

Has WHOI or someone has designed a 3000m pressure housing with optical port?

It isn't clear whether the quote includes a lens or what the lens options are. Do you know what WHOI uses for a lens and whether it can be focused or zoomed by remote control (I assume we want that)? I sent an e-mail to Dave to see what the lens options are from Prosilica.

The camera has 3 logic outputs - unfortunately that isn't enough controls for pan, tilt, zoom, lights, etc. A microcontroller could communicate over the Ethernet or RS-232.

Cost estimate to put the Prosilica camera on the network:

- Prosilica Camera $ 7,590
- Lens with remote focus & zoom $ 1,000
????
- Ti Pressure case with optical port $10,000
????? from WHOI?
- heavy duty pan & tilt
$14,000
ROS
- 2 x 200W HID lights with ballast 2 x $2750 $ 5,500
- titanium interface housing with:
$10,000
400-12/24/100V converter (for lights)
$ 4,000
controller for lights and pan & tilt $ 2,500
- frame
$ 5,000
- labor 1 month x $20,000 $20,000
- contingency $10,000

total $89,590

I have requested a quote for 2 400W lights from DSP&L.

Tim

> -----Original Message-----
> From: dskelley@u.washington.edu [mailto:dskelley@u.washington.edu]
> Sent: Wednesday, November 07, 2007 9:11 AM
> To: tmcginnis@apl.washington.edu
> Cc: harkins@apl.washington.edu; mikeh@apl.washington.edu
> Subject: RE: GE2040 Camera - Quotation Q070460 attached (fwd)
>
> Hi Guys, here information on the Proscilica still camera. I have the
> other components costed out from Dan Fornari..Tim, I think either one
> of these bumps the data rate up, also it would need 2 400W strobes I
> believe. deb
>
> Dr. Deborah S. Kelley
> School of Oceanography
> Box 357940
> Seattle WA, 98195
> 206-543-9279
>
> Lab Group http://www.vents.washington.edu Lost City Expedition
> http://www.lostcity.washington.edu/
> Visions05 Expedition http://www.visions05.washington.edu/
>
> ---------- Forwarded message ----------
> Date: Wed, 7 Nov 2007 08:59:48 -0800
> From: David Frosini <dfrosini@prosilica.com>
> To: dskelley@u.washington.edu
> Subject: RE: GE2040 Camera - Quotation Q070460 attached
>
> Deborah,
>
> Budgetary Quotation Q070460, for two GE2040 cameras is attached.
> We also have a new model, the GC2450, which is priced at $ 4,290.
> Here's link to the camera:
> http://www.prosilica.com/products/gc2450.html
>
> The GE2040 has a much larger image sensor than the GC2450, so the
> dynamic range is higher. For multiple installations, the GC2450 might
> help to lower costs.
>
> Note also that all of our GE and GC series cameras have the ability
to
> communicate with RS-232 peripherals through the GigE port. This might
> help to minimize cabling if any RS-232 equipment is included in the
> installation.
>
> Thank you for your request, and please contact me for any additional
> questions.
>
> Best Regards,
> Dave
>

5618 Copley Drive
San Diego, CA 92111
Cell (619) 884 - 1813
Office (858) 565 – 8500 ext.:109
fax (858) 565 - 8808

```
>
> - ---------------------------------------------------
> David Frosini
> Eastern Region Sales Manager
> Prosilica USA Inc.
> Tel: (585) 391-1429
> Mobile: (585) 230-8829
> FAX: (585) 391-1463
> Email: dfrosini@prosilica.com
> Visit us at:  www.prosilica.com
>
>
>
> - -----Original Message-----
> From: dskelley@u.washington.edu [mailto:dskelley@u.washington.edu]
> Sent: Saturday, November 03, 2007 6:24 PM
> To: David Frosini
> Cc: jdelaney@u.washington.edu
> Subject: GE2040 Camera
>
> Dear Dave,
>
> We are in the final planning stages for implementation of a 1500 km
> cabled underwater observatory off the WA and OR coast. The system
will
> include telecommunication fiber optic cables to sites of interest off
> shore (seafloor hot spring systems, underwater volcanoes etc).
> Hundreds of sensors will be connected onto this observatory, bringing
> imagery and data to researchers and the public 24/7 over the
internet.
>
> As part of this project I am investigating various cameras that could
> be hooked onto our system (once placed in an appropriate pressure
> housing w/ lights etc). I have been in contact with Dan Fornari at
> Woods Hole Oceanographic Institution and they recently purchased a
> GE2040 camera from you and he speaks highly of it. It would help in
> our costing processes if I could get a quote from you for 2 of these
> cameras. Thanks much and I look forward to hearing from you.
>
> Dr. Deborah S. Kelley
> Regional Scale Cabled Observatory
> Project Scientist
> School of Oceanography
> Box 357940
> Seattle WA, 98195
> 206-685-9556
>
> Regional Observatory http://www.ooi.washington.edu/ Lab Group
> http://www.vents.washington.edu Lost City Expedition
> http://www.lostcity.washington.edu/
> Visions05 Expedition http://www.visions05.washington.edu/
>
```

REMOTE OCEAN SYSTEMS

bc@rosys.com

QUOTATION

Applied Physics Lab University of Washington	Quote No: QBC-80170
Attn: Skip Denny	Date: September 26, 2008
206.543.8042	

Page: 1 of 1 denny@apl.washington.edu

Item	PN	*Description*	*Qty*	*Price*	*Extended*
1	52-29000-AT02	Underwater 1080i high definition color camera, Inspector HD, 10:1 zoom, 60i video format, 2-lux sensitivity, 12-24VDC input power, titanium housing, 4000-meter depth, RS485 controlled, 6.1 megapixel still image capture, fitted with a Burton 2013 connector	1	$21,660.00	$21,660.00
2	70-08097-01	Inspector HD camera clamp	1	$305.00	$305.00
3	21-10035-01	Dual axis pan & tilt assembly, PT10, RS485 controlled, 24VDC, 3000-meter depth, 88:1 harmonic gears, oil-filled, aluminum hard black anodized housing, mounting plate, stop collar GUI, software protocol, feedback, limit switches, LPMBH 4-MP connector	1	$8,995.00	$8,995.00
4	70-08124-01	PT10 yoke bracket to mount camera and dual lights	1	$370.00	$370.00
5	10-00275-09	LED Smartlight II, RS485 controlled, 24VDC, aluminum hard black anodized housing, 3000-meter depth, 104_0 field of view in water, 1000 lumens, 5500_0 K, LPMBH-4-MP connector	2	$1,500.00	$3,000.00
				Total $34,680.00	
6	10-00243-01	LED Smartlight II brackets	2	$175.00	$350.00

Terms 2) Validity: 60 days 3) Delivery: 6-8 weeks, contingent on time of order 4) FOB: San Diego, CA 92111 5) Payment: Net30 6) Packaging: Prices include standard commercial packaging 7) Additional: ROS standard Terms & Conditions of Sale available upon request 8) Quantity: Purchase quantities other than those herein specified require separate quotation

By: *Beto Campos* Beto Campos Regional Account Manager

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00034**
For:	CTD
Type:	Budgetary Quote / email
Date:	22 September 2008
Company:	Sea-Bird Electronics
Requested By:	SD

Notes: typically CTD also has DO and/or pH on it

SBE

Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com

FAX: (425) 643-9954
Tel: (425) 643-9866
Email: seabird@seabird.com

SBE Quotation # 52216Q

Date: September 22, 2008

TO: University of Washington / Applied Physics Lab

ATTN: Skip Denny

FROM: Doug Bennett

Sea-Bird Electronics is pleased to submit our **Quotation Number 52216Q** as follows:

Item	SBE Num	Qty	Description	List Price	Qty Disc (%)	Edu Disc (%)	Disc Unit Price	Ext. Disc Price
1	52MP	17	Moored Profiler CTD - Includes 7000 meter titanium housing, RS-232 or logic level serial interface, AF24173 Anti-Foulant Devices, 2.4 meter data/power interface cable (PN 801385), SEASOFT software, and complete documentation. Specify: serial interface and pressure sensor range (depth) selection.	10,060.00	6.8	15.0	7,969.53	135,482.01
1a	52-1a	17	RS-232 Serial Interface	.00	0.0	15.0	.00	.00
1b	52-2x	17	Strain gauge pressure sensor – available ranges are 20, 100, 350, 600, 1000, 2000, 3500 or 7000 meters. Specify pressure range desired.	.00	0.0	15.0	.00	.00
1c	52-3a	17	Integrate 7000 meter SBE 43F Dissolved Oxygen Sensor	4,470.00	6.8	15.0	3,541.13	60,199.21
2	16plus-IM V2	1	**SEACATplus Version 2 - Conductivity and Temperature Recorder with Inductive Modem.** Includes 64 MB memory, 6 differential A/D channels (0 - 5 volt input range), 1 RS-232 data input channel, AF24173 anti-foulant devices, SEASOFT software, and complete documentation.	10,315.00	0.0	15.0	8,767.75	8,767.75
2a	16p-1a	1	**600 meter** plastic housing					

2b	16p-2s	1	600 meter strain gauge pressure sensor	1,230.00	0.0	15.0	1,045.50	1,045.50
2c	16p-4f	1	Add SBE 5P plastic pump for sensor flushing, Standard XSG/RMG connectors (includes data I/O and pump Y-cable 17797, and mount)	1,695.00	0.0	15.0	1,440.75	1,440.75
2d	16p-7c	1	SBE 43 Dissolved Oxygen Sensor (Mooring Configuration), 600 meter plastic, (cable and mount included, requires option 16p-4b or f)	4,405.00	0.0	15.0	3,744.25	3,744.25
2e	18	1	pH SENSOR - Modular sensor, 1200 meter depth capability, output 0-5 V.	1,560.00	0.0	15.0	1,326.00	1,326.00
2f	pHInteg	1	Cable, mount and integration	200.00	0.0	15.0	170.00	170.00
2g	24350	1	WET Labs ECO-FLNTUS, Chlorophyll & Turbidity sensor with bio-wiper™, 75 µg/l & 200 NTU, **200 meter**	7,050.00	0.0	15.0	5,992.50	5,992.50
2h	ECOInt-2a	1	ECO & CTD integration (strap-on) for CTD with Standard Connectors, includes cabling and mounting	280.00	0.0	15.0	238.00	238.00
2i	24349	1	WET Labs ECO-PAR(S) PAR sensor (400-700 nm), cosine response, with bio-wiper™, **200 meter**	4,285.00	0.0	15.0	3,642.25	3,642.25
2j	ECOINT-2a	1	ECO & CTD integration (strap-on) for CTD with Standard Connectors, includes cabling and mounting	280.00	0.0	15.0	238.00	238.00
							Total List Prices :	**$278,310.00**
							Quantity Discount :	**<$16,796.68>**
							Educational Discount :	**<$39,227.10>**
							Net Total (FOB Factory):	**$222,286.22**

TERMS: Prices in USA Dollars, FOB Factory, Bellevue, Washington. A 15% Educational Discount is included in this quote. Freight and insurance charges can be billed “Collect” or prepaid and added to our invoice. Payment is due Net 30 days from date of shipment. A service charge (computed at an annual rate of 12% and beginning on the 31st day) will be assessed on all accounts not paid within 30 days. Delivery: Typically 8 weeks after receipt of order. This quote is valid through 31 December, 2008.

For Sea-Bird Electronics, Inc.
Doug Bennett

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00035**
For:	Dissolved Oxygen (DO)
Type:	Budgetary Quote / email
Date:	22 September 2008
Company:	Sea-Bird Electronics
Requested By:	SD

Notes: typically CTD also has DO and/or pH on it

SBE

Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com

FAX: (425) 643-9954
Tel: (425) 643-9866
Email: seabird@seabird.com

SBE Quotation # 52216Q

Date: September 22, 2008

TO: University of Washington / Applied Physics Lab

ATTN: Skip Denny

FROM: Doug Bennett

Sea-Bird Electronics is pleased to submit our **Quotation Number 52216Q** as follows:

Item	SBE Num	Qty	Description	List Price	Qty Disc (%)	Edu Disc (%)	Disc Unit Price	Ext. Disc Price
1	52MP	17	Moored Profiler CTD - Includes 7000 meter titanium housing, RS-232 or logic level serial interface, AF24173 Anti-Foulant Devices, 2.4 meter data/power interface cable (PN 801385), SEASOFT software, and complete documentation. Specify: serial interface and pressure sensor range (depth) selection.	10,060.00	6.8	15.0	7,969.53	135,482.01
1a	52-1a	17	RS-232 Serial Interface	.00	0.0	15.0	.00	.00
1b	52-2x	17	Strain gauge pressure sensor – available ranges are 20, 100, 350, 600, 1000, 2000, 3500 or 7000 meters. Specify pressure range desired.	.00	0.0	15.0	.00	.00
1c	52-3a	17	Integrate 7000 meter SBE 43F Dissolved Oxygen Sensor	4,470.00	6.8	15.0	3,541.13	60,199.21
2	16plus-IM V2	1	**SEACATplus Version 2 - Conductivity and Temperature Recorder with Inductive Modem.** Includes 64 MB memory, 6 differential A/D channels (0 - 5 volt input range), 1 RS-232 data input channel, AF24173 anti-foulant devices, SEASOFT software, and complete documentation.	10,315.00	0.0	15.0	8,767.75	8,767.75
2a	16p-1a	1	**600 meter** plastic housing					

2b	16p-2s	1	600 meter strain gauge pressure sensor	1,230.00	0.0	15.0	1,045.50	1,045.50
2c	16p-4f	1	Add SBE 5P plastic pump for sensor flushing, Standard XSG/RMG connectors (includes data I/O and pump Y-cable 17797, and mount)	1,695.00	0.0	15.0	1,440.75	1,440.75
2d	16p-7c	1	SBE 43 Dissolved Oxygen Sensor (Mooring Configuration), 600 meter plastic, (cable and mount included, requires option 16p-4b or f)	4,405.00	0.0	15.0	3,744.25	3,744.25
2e	18	1	pH SENSOR - Modular sensor, 1200 meter depth capability, output 0-5 V.	1,560.00	0.0	15.0	1,326.00	1,326.00
2f	pHInteg	1	Cable, mount and integration	200.00	0.0	15.0	170.00	170.00
2g	24350	1	WET Labs ECO-FLNTUS, Chlorophyll & Turbidity sensor with bio-wiper™, 75 µg/l & 200 NTU, **200 meter**	7,050.00	0.0	15.0	5,992.50	5,992.50
2h	ECOInt-2a	1	ECO & CTD integration (strap-on) for CTD with Standard Connectors, includes cabling and mounting	280.00	0.0	15.0	238.00	238.00
2i	24349	1	WET Labs ECO-PAR(S) PAR sensor (400-700 nm), cosine response, with bio-wiper™, **200 meter**	4,285.00	0.0	15.0	3,642.25	3,642.25
2j	ECOINT-2a	1	ECO & CTD integration (strap-on) for CTD with Standard Connectors, includes cabling and mounting	280.00	0.0	15.0	238.00	238.00
							Total List Prices :	**$278,310.00**
							Quantity Discount :	**<$16,796.68>**
							Educational Discount :	**<$39,227.10>**
							Net Total (FOB Factory):	**$222,286.22**

TERMS: Prices in USA Dollars, FOB Factory, Bellevue, Washington. A 15% Educational Discount is included in this quote. Freight and insurance charges can be billed “Collect” or prepaid and added to our invoice. Payment is due Net 30 days from date of shipment. A service charge (computed at an annual rate of 12% and beginning on the 31st day) will be assessed on all accounts not paid within 30 days. Delivery: Typically 8 weeks after receipt of order. This quote is valid through 31 December, 2008.

For Sea-Bird Electronics, Inc.
Doug Bennett

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00036**
For:	pH
Type:	Budgetary Quote / email
Date:	22 September 2008
Company:	Sea-Bird Electronics
Requested By:	SD

Notes: typically CTD also has DO and/or pH on it, pH has an
Analog output and needs digitizing.

SBE

Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com

FAX: (425) 643-9954
Tel: (425) 643-9866
Email: seabird@seabird.com

SBE Quotation # 52216Q

Date: September 22, 2008

TO: University of Washington / Applied Physics Lab

ATTN: Skip Denny

FROM: Doug Bennett

Sea-Bird Electronics is pleased to submit our **Quotation Number 52216Q** as follows:

Item	SBE Num	Qty	Description	List Price	Qty Disc (%)	Edu Disc (%)	Disc Unit Price	Ext. Disc Price
1	52MP	17	Moored Profiler CTD - Includes 7000 meter titanium housing, RS-232 or logic level serial interface, AF24173 Anti-Foulant Devices, 2.4 meter data/power interface cable (PN 801385), SEASOFT software, and complete documentation. Specify: serial interface and pressure sensor range (depth) selection.	10,060.00	6.8	15.0	7,969.53	135,482.01
1a	52-1a	17	RS-232 Serial Interface	.00	0.0	15.0	.00	.00
1b	52-2x	17	Strain gauge pressure sensor – available ranges are 20, 100, 350, 600, 1000, 2000, 3500 or 7000 meters. Specify pressure range desired.	.00	0.0	15.0	.00	.00
1c	52-3a	17	Integrate 7000 meter SBE 43F Dissolved Oxygen Sensor	4,470.00	6.8	15.0	3,541.13	60,199.21
2	16plus-IM V2	1	**SEACATplus Version 2 - Conductivity and Temperature Recorder with Inductive Modem.** Includes 64 MB memory, 6 differential A/D channels (0 - 5 volt input range), 1 RS-232 data input channel, AF24173 anti-foulant devices, SEASOFT software, and complete documentation.	10,315.00	0.0	15.0	8,767.75	8,767.75
2a	16p-1a	1	**600 meter** plastic housing					

2b	16p-2s	1	600 meter strain gauge pressure sensor	1,230.00	0.0	15.0	1,045.50	1,045.50
2c	16p-4f	1	Add SBE 5P plastic pump for sensor flushing, Standard XSG/RMG connectors (includes data I/O and pump Y-cable 17797, and mount)	1,695.00	0.0	15.0	1,440.75	1,440.75
2d	16p-7c	1	SBE 43 Dissolved Oxygen Sensor (Mooring Configuration), 600 meter plastic, (cable and mount included, requires option 16p-4b or f)	4,405.00	0.0	15.0	3,744.25	3,744.25
2e	18	1	pH SENSOR - Modular sensor, 1200 meter depth capability, output 0-5 V.	1,560.00	0.0	15.0	1,326.00	1,326.00
2f	pHInteg	1	Cable, mount and integration	200.00	0.0	15.0	170.00	170.00
2g	24350	1	WET Labs ECO-FLNTUS, Chlorophyll & Turbidity sensor with bio-wiper™, 75 µg/l & 200 NTU, **200 meter**	7,050.00	0.0	15.0	5,992.50	5,992.50
2h	ECOInt-2a	1	ECO & CTD integration (strap-on) for CTD with Standard Connectors, includes cabling and mounting	280.00	0.0	15.0	238.00	238.00
2i	24349	1	WET Labs ECO-PAR(S) PAR sensor (400-700 nm), cosine response, with bio-wiper™, **200 meter**	4,285.00	0.0	15.0	3,642.25	3,642.25
2j	ECOINT-2a	1	ECO & CTD integration (strap-on) for CTD with Standard Connectors, includes cabling and mounting	280.00	0.0	15.0	238.00	238.00
							Total List Prices :	**$278,310.00**
							Quantity Discount :	**<$16,796.68>**
							Educational Discount :	**<$39,227.10>**
							Net Total (FOB Factory):	**$222,286.22**

TERMS: Prices in USA Dollars, FOB Factory, Bellevue, Washington. A 15% Educational Discount is included in this quote. Freight and insurance charges can be billed "Collect" or prepaid and added to our invoice. Payment is due Net 30 days from date of shipment. A service charge (computed at an annual rate of 12% and beginning on the 31st day) will be assessed on all accounts not paid within 30 days. Delivery: Typically 8 weeks after receipt of order. This quote is valid through 31 December, 2008.

For Sea-Bird Electronics, Inc.
Doug Bennett

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00037**
For:	PAR
Type:	Budgetary Quote / email
Date:	17 September 2008
Company:	BioSpherical Instruments
Requested By:	SD

Notes: 2π steradian, upward looking

Biospherical Instruments Inc.
5340 Riley Street, San Diego, CA 92110-2621 USA (619) 686-1888

	COSINE PAR SENSORS	
Model Number	Description	Domestic Price
QCP-2100	**Cosine PAR Sensor with digital signal output**, allowing direct connection to a PC or laptop computer. Measures cosine-corrected funderwater PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Logger-2100, data-acquisition software is included for live display or time series logging of calibrated values. This sensor may operate to distances of 250 meters from the host PC. Order Separately: DSM-2100 signal manifold, QSP-210 lowering frame, and QSC-2100 cable (required).	$1,225
New Product QCP-2150	**Cosine PAR Sensor with ASCII signal output**. Measures underwater PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. This sensor outputs data in ASCII format, allowing integration with third-party data-acquisition systems. This sensor is equipped with #MCBH-4-M bulkhead connector. (Contact factory for details)	$1,225
QCP-2200	**Cosine PAR Sensor with a single-channel analog output**, signal voltage is proportional to incident PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Cosine-corrected for use underwater to depths of 2000 m. Designed specifically for users of CTD and other limited-range data acquisition systems. Order Separately: QSP-210 lowering frame, and PSC-305 underwater cable (required).	$1,225
New Product QCP-2200-HP	**Cosine PAR Sensor with single-channel analog output and high-pressure bulkhead connector.** The signal voltage is proportional to incident PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Cosine corrected for use underwater and rated to a depth of 10,000m. XSG-4-BCL-HP connector is used.	$1,325
QCP-2200PD	**Cosine PAR Sensor with Photo-Detector only**. This specialised sensor has no internal signal processing and outputs a current, proportional to incident PAR (Photosynthetically Available Radiation 400-700nm). This sensor is cosine-corrected for underwater use and rated to depths of 2000m. Note: The QCP-2200PD is intended for use with a CTD system.	$1,225
New Product QCP-2200PD-HP	**Cosine PAR Sensor with Photo-Detector only and high-pressure bulkhead connector**. This specialised sensor has no internal signal processing and outputs a current, proportional to incident PAR (Photosynthetically Available Radiation 400-700nm). Cosine corrected for use underwater and rated to a depth of 10,000m. XSG-4-BCL-HP connector is used. Note: The QCP-2200PD-HP is intended for use with a CTD system.	$1,325
QCP-2300	**Cosine PAR Sensor with Log Output**. For use with 12 bit ADC systems. Single channel analog output voltage is proportional to the log of incident PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Cosine corrected for use underwater and rated to depths up to 2000 m. Order Separately: QSP210 lowering frame, PSC-305 underwater cable (required).	$1,755
New Product QCP-2300-HP	**Cosine PAR Sensor with Log Output and high-pressure bulkhead connector**. For use with 12 bit ADC systems. Single channel analog output voltage is proportional to the log of incident PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Cosine corrected for use underwater and rated to depths up to 10,000 m.XSG-4-BCL-HP connector is used. Note: The QCP-2300-HP is intended for use with a CTD system. (Contact factory for details.)	$1,855
New Product QCP-2350	**Cosine PAR Sensor with Log Output and equipped with Impulse #MCBH-4-M bulkhead connector** and intended for use with 12 bit ADC systems. Single channel analog output voltage is proportional to the log of incident PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Cosine corrected for use underwater and rated to depths up to 2000 m. (Contact factory for details.)	$1,780
QCR-2100	**Surface Cosine PAR Sensor with digital signal output**, allowing direct connection to a PC or laptop computer. Measures cosine-corrected PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Logger-2100, data-acquisition software is included for live display or time series logging of calibrated values. This sensor may operate to distances of 250 meters from the host PC. Order Separately: QSC-2145 weatherproof cable (required), DSM-2100 signal manifold.	$1,225
New Product QCR-2150	**Surface Cosine PAR Sensor with with ASCII signal output.** For in-air measurement of cosine-corrected PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. This sensor outputs data in ASCII format, allowing integration with third-party data-acquisition systems.(Contact factory for details)	$1,225
QCR-2200	**Surface Cosine PAR Sensor with analog signal output**. For measurement of incident PAR (Photosynthetically Available Radiation; 400-700 nm) irradiance. Cosine corrected for use in air. Used as surface reference for data from underwater cosine PAR sensors (e.g. QCP-2100, QCP-2200, QCP-2300). Designed specifically for users of CTD and other limited-range data acquisition systems.	$1,225
QSC-2100	Underwater Shielded Cable with Kevlar® reinforcement, for digital output sensors QSP, QSPL, QCP, MCP and BIC radiometers. Standard lengths are 100, 50 and 25 m. Contact factory for custom lengths. Priced as base molding charge plus cost per meter of cable.	$400 + $8.25/m
QSC-2105	Underwater Power-data Cable for digital output QSPL sensors. This cable has no internal reinforcement and it is not suitable for load-bearing applications. The maximum length of this cable is 100M. Priced as base molding charge plus cost per meter of cable.	$300+$12.50/m
PSC-305	Underwater Shielded Cable with Kevlar® reinforcement. For analog output QSP and QCP-2200 or 2300 sensors. Standard lengths are 100, 50, and 25 m. Contact factory for custom lengths. Priced as base molding charge plus cost per meter of cable.	$200 + $8.25/m
QSC-2145	Weather-resistant Shielded Cable for digital output QSR, QCR and MCR-2100 surface sensors. Priced as base molding charge plus cost per meter.	$150 + $1.75/m
QSC-2245	Weather-resistant Shielded Cable for analog output QSR or QCR-2200, surface sensors. Priced as base molding charge plus cost per meter.	$150 + $1.75/m

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00038**
For:	Spectral Irradiance
Type:	Budgetary Quote / email
Date:	17 Sept 2008
Company:	Satlantic
Requested By:	SD

Notes: OCR-507 segment of quote
.

2008-Sep-17

QUOTATION

QUOTATION: 2147-5200

ATTN:	Skip Denny University of Washington
FAX:	
TEL:	206-543-8042
FROM:	Robert Burns

Customer address:

Applied Physics Lab
1013 40th St. NE
Seattle
WA
USA

Qty:	Code:	Description:	Unit Cost:	Cost:
4	**ISUS V3**	ISUS Chemical Free Nitrate Analyzer Accuracy : +/- 2uM (0.028 mg/l) or +/- 10% of readings, whichever is greater. Detection Range : 0.5 to 2000 uM (0.007 to 28 mg/l) Power Requirements : 6 – 18 VDC (Non-isolated power input from batteries) input voltage 19 - 75 VDC Isolated power input 9 - 36 VDC (Optional isolated power input) voltage 6.5 Watts (0.54 A @ 12 V) power consumption Internal Data Storage for Long Term Deployments : 256 MB data storage Flexible scheduling interface Real Time Data Collection : Real-time nitrate output @ 1.0 Hz Calibrated nitrate analog output 0 - 5 VDC Telemetry Options : RS-232, RS-485 and USB telemetry options General : Full UV absorption spectra 1000 h lamp lifetime 1000 meter depth rating Data collection and processing software included Shipping Case : Molded shipping case	**28,900.00**	**115,600.00**

2008-Sep-17

QUOTATION

QUOTATION: 2147-5200

Qty:	Code:	Description:	Unit Cost:	Cost:
4	**ISUS CAB KIT**	Power, Serial and USB Cable Kit 2 pin pigtail 6 pin power telemetry cable 8 pin USB download cable	**690.00**	**2,760.00**
4	**FLOW CELL**	Delrin flow cell	**400.00**	**1,600.00**
4	**FOUL GUARD**	Copper Anti-fouling Cap for Mooring Applications	**1,000.00**	**4,000.00**
4	**OCR507 ICSW**	7 Channel Irradiance Cosine Water (Ed, Eu) Micro 7-Channel Sensor 12 VDC operation 24 bit DSP data acquisition 18 Bit dynamic range 7 - 24 Hz frame rate 9 – 18 VDC operation Digital Output - RS232, RS 485, & SATNet Network Telemetry Corrosion proof housing 350 meter depth rating See www.satlantic.com/optics for more information.	**8,100.00**	**32,400.00**
1	**1700 Series**	1700 series custom molded Pelican case	**355.00**	**355.00**

Sub total: 156,715.00

Total: ($U.S.) **156,715.00**

Notes:

RMA Number:

Delivery: 10-12 weeks. Delivery to be confirmed at time of order.

Customs: Duties or taxes not included in quotation

Shipping: Provided by customer

Terms: US funds. Net payable 30 days.
3% Charge applied to overdue accounts after 30 days.
Quotation valid for eight weeks from date of quotation.

N.C. C.D.

SIGNATURE: ____________________

Robert Burns

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00039**
For:	ISUS Nitrate
Type:	Budgetary Quote / email
Date:	17 September 2008
Company:	Satlantic
Requested By:	SD

Notes:

SATLANTIC

2008-Sep-17

QUOTATION

QUOTATION: 2147-5200

ATTN:	Skip Denny University of Washington
FAX:	
TEL:	206-543-8042
FROM:	Robert Burns

Customer address:

Applied Physics Lab
1013 40th St. NE
Seattle
WA
USA

Qty:	Code:	Description:	Unit Cost:	Cost:
4	**ISUS V3**	ISUS Chemical Free Nitrate Analyzer Accuracy : +/- 2uM (0.028 mg/l) or +/- 10% of readings, whichever is greater. Detection Range : 0.5 to 2000 uM (0.007 to 28 mg/l) Power Requirements : 6 – 18 VDC (Non-isolated power input from batteries) input voltage 19 - 75 VDC Isolated power input 9 - 36 VDC (Optional isolated power input) voltage 6.5 Watts (0.54 A @ 12 V) power consumption Internal Data Storage for Long Term Deployments : 256 MB data storage Flexible scheduling interface Real Time Data Collection : Real-time nitrate output @ 1.0 Hz Calibrated nitrate analog output 0 - 5 VDC Telemetry Options : RS-232, RS-485 and USB telemetry options General : Full UV absorption spectra 1000 h lamp lifetime 1000 meter depth rating Data collection and processing software included Shipping Case : Molded shipping case	**28,900.00**	**115,600.00**

2008-Sep-17

QUOTATION

QUOTATION: 2147-5200

Qty:	Code:	Description:	Unit Cost:	Cost:
4	**ISUS CAB KIT**		**690.00**	**2,760.00**
		Power, Serial and USB Cable Kit 2 pin pigtail 6 pin power telemetry cable 8 pin USB download cable		
4	**FLOW CELL**		**400.00**	**1,600.00**
		Delrin flow cell		
4	**FOUL GUARD**		**1,000.00**	**4,000.00**
		Copper Anti-fouling Cap for Mooring Applications		
4	**OCR507 ICSW**		**8,100.00**	**32,400.00**
		7 Channel Irradiance Cosine Water (Ed, Eu) Micro 7-Channel Sensor 12 VDC operation 24 bit DSP data acquisition 18 Bit dynamic range 7 - 24 Hz frame rate 9 – 18 VDC operation Digital Output - RS232, RS 485, & SATNet Network Telemetry Corrosion proof housing 350 meter depth rating See www.satlantic.com/optics for more information.		
1	**1700 Series**		**355.00**	**355.00**
		1700 series custom molded Pelican case		

Sub total:		156,715.00
Total:	($U.S.)	**156,715.00**

Notes:

RMA Number:

Delivery: 10-12 weeks. Delivery to be confirmed at time of order.

Customs: Duties or taxes not included in quotation

Shipping: Provided by customer

Terms: US funds. Net payable 30 days.
3% Charge applied to overdue accounts after 30 days.
Quotation valid for eight weeks from date of quotation.

N.C. C.D.

SIGNATURE: ____________________

Robert Burns

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00040**
For:	ADCP
Type:	Budgetary Quote / email
Date:	22 September 2008
Company:	TRDI
Requested By:	SD

Notes: 150 kHz (300m) and 75 kHz (600m) ADCPs

TELEDYNE
RD INSTRUMENTS
A Teledyne Technologies Company

Date: *22 September 2008*

Number of pages (incl. cover sheet) *5*

Company: UW-APL
Attn: Skip Denny
Phone: 206 543 8042
Fax:
Email: denny@apl.washington.edu

FROM: *Patrick Bradley*
Phone *858.842.2747*
Fax *858.842.2822*

Skip,

Thanks for your time last week. I have included a quotation for quantity two TRDI 75kHz Work-Horse Long Ranger Direct Read ADCP's and quantity five WH Quartermaster 150 kHz ADCP's with 3000 meter depth rating for integration into the Regional Scales Nodes of the OOI.
TRDI patented Broadband ADCPs are the proper choice for the collection of reliable, robust velocity profile information for real time cabled observatories for the following reasons:

- RD Instruments 4th beam provides a unique data quality measure called 'Error Velocity', a quantitative data quality assurance parameter for use during data collection, a peer review process, or in a court of law.
- RD Instruments error velocity is the most effective method for identifying interference from mooring lines and fish and is superior to methods relying only on acoustic echo intensity or velocity standard deviation.
- RD Instruments patented BroadBand signal processing provides the rapid sampling that is required to screen out intermittent interference in the velocity measurements that are caused by fish or mooring lines.
- This same Broadband embedded Technology is brilliant at delivering more information per ping over its narrowband counterparts, efficiently making the most of each ping without sacrificing data quality.
- TRDI internal processing automatically screens each ping for interference and can still perform a "three beam" solution if interference is identified.

The Direct reading configuration, or "monitor" version of the Long Ranger and Quartermaster excludes the internal batteries, has a short pressure case to house the electronics, and requires external power.

TELEDYNE
RD INSTRUMENTS
A Teledyne Technologies Company

Quote # 80034MM **Valid through 22 November, 2008**

Line #	Part #	Description	Unit Price	Qty.	Total Price
1	WHLM75	Workhorse Long Ranger 75 kHz Direct Read ADCP includes a 2000 meter rated Pressure Sensor.	$49,900	2	$99, 800
2	WHM150-3000	3000 meter depth rated WH Monitor 150 kHz Direct Read ADCP, includes 4000 meter Pressure Rating	$40,975	5	$204, 875
	Subtotal				$304,675
		RD Instruments Marine Measurements Volume Discount Policy 2008		5%	$15,234
					$289,441
		Teledyne RD Instruments Terms and Conditions are a part of this offer and acceptance is limited to these terms			
	Delivery	Standard Delivery 60 day, ARO standard, Shipped FOB shipping point San Diego, CA USA			

In addition, I am pleased to include our new pricing on the optional extension of our Factory Warranty. Our standard products all include a (1) one-year from date of shipment Factory Limited Warranty, covering defects in materials and workmanship (see below T&C statement). We are now offering extensions on the standard factory warranty, in increments of one additional year, at merely 3% of the list price for each product covered. For the above quote, a one-year Warranty Extension (Part # EX1YRWAR) on the above systems would be $304,675 X .03) = $9140 per additional year. Purchasing a quantity of (2) additional years would then provide a total 3-year Factory Limited Warranty for only $18,280 additional to the product quote.

				Qty	
3	EX1YRWAR	1-Year Extension of Factory Limited Warranty (Included one year + extension = 2 years total)	3% List per year	1.	$9,140
4	EX2YRWAR	1-Year Extension of Factory Limited Warranty (Included one year + extensions = 3 years total)	3% List per year	2.	$18,280

Regards,

Patrick Bradley
Teledyne RD Instruments
858 842 2747

Terms and Conditions of Sale

1. DEFINITIONS

"Seller" means Teledyne RD Instruments, Inc. "Buyer" means the legal entity purchasing Goods from Seller. "Goods" means the products offered by Seller and/or purchased by Buyer. "Offer" means any quote, proposal, or offer to sell Goods provided by Seller to Buyer. "Order" means any purchase order or similar instrument issued by Buyer to Seller to purchase Goods. Seller and Buyer are sometimes referred to herein individually as a "Party" and collectively as the "Parties".

2. ACCEPTANCE

The terms and conditions included in this "Terms and Conditions of Sale" document (hereinafter, this "Agreement") apply to all Offers made by Seller to Buyer and all Buyer's Orders accepted by Seller. Acceptance of Buyer's Order, and any changes or amendments thereto, is expressly conditioned upon Buyer's assent to these terms and conditions. Unless specifically agreed to in writing by a duly authorized representative of Seller, Seller objects to, and is not bound by, any terms or conditions that differ from or add to the terms and conditions specified herein. Seller's failure to object to any terms and conditions or any other provisions contained in any communication from Buyer, including, but not limited to, Buyer's Orders, does not waive any of the terms and conditions specified herein. Seller's acceptance of any resulting Order or Buyer's receipt of Goods, whichever occurs first, will conclusively evidence Buyer's unconditional acceptance of these terms and conditions.

3. PRICES

Unless stated otherwise in writing by Seller, all prices are stated in U.S. Dollars and the prices offered are valid for a period of thirty (30) days from the date of Seller's Offer. The prices offered apply only to the specific quantities, specifications, and delivery schedules set forth in Seller's Offer. Any variation in quantity, specifications, or delivery schedules may necessitate a price and/or delivery schedule adjustment. Unless stated otherwise, all prices for domestic deliveries are F.O.B. Seller's place of shipment, as defined in the Uniform Commercial Code (UCC), and all prices for international deliveries are Ex-Works, as defined by INCOTERMS 2000.

4. CREDIT APPROVAL AND PAYMENT

Standard payment terms are net thirty (30) days from date of Seller's invoice, subject to credit approval of Buyer by Seller. Credit terms, shipments, and performance of work are at all times subject to the approval of Seller's Credit Department. International orders may require cash in advance or an irrevocable letter of credit confirmed with Teledyne's bank. Each shipment is a separate and independent transaction and payment must be made by Buyer accordingly.

If, prior to shipment of Buyer's Order, Buyer fails to fulfill the terms of payment of any prior invoice submitted by Seller, or if, in the opinion of Seller, Buyer's financial condition becomes impaired or unsatisfactory, Seller reserves the right to change, without notice, the terms of payment and/or delay or discontinue further shipments, without prejudice to any other available legal remedies, until past due obligations have been paid and Seller has received acceptable assurance regarding Buyer's prompt payment of future obligations. All amounts due to Seller but not paid by Buyer on the due date bear interest payable by Buyer to Seller in U.S. Dollars at a rate that is equal to the lesser of (i) one and one-half percent (1.5%) per month, or (ii) the maximum interest rate permitted under applicable law. Interest accrues on the balance of unpaid amounts as of the date on which portions of those amounts become due until the date payment is received by Seller. Buyer will also be liable to Seller for any expenses incidental to collection of past due amounts, including reasonable attorney's fees and court costs. In the event of Buyer's bankruptcy or insolvency, Seller is entitled to terminate any Order then outstanding and to receive reimbursement for termination costs and expenses as provided under Article 13, Termination for Default.

5. TAXES

The amount of any present or future sales, use, excise, import duty, or other tax applicable to the manufacture, sale, or lease of Goods will be added to the invoice and must be paid by Buyer, unless the Buyer provides Seller with a tax exemption certificate acceptable to the applicable taxing authority.

6. SHIPPING TERMS AND RISK OF LOSS

All domestic shipments by Seller are F.O.B. Seller's place of shipment, as defined in the Uniform Commercial Code. All international shipments by Seller are Ex-Works, as defined by INCOTERMS 2000. Risk of loss for Goods will transfer to Buyer upon Seller presenting Goods to carrier. If Seller prepays shipping, insurance, or other related costs, Buyer agrees to reimburse Seller promptly for the actual costs incurred by Seller.

7. TOOLING

Unless otherwise provided by special written agreement signed by Seller and Buyer, all tooling, fixtures, equipment, tools, and designs produced, acquired, or used by Seller for the purposes of filling Buyer's Order remain the property of the Seller.

8. PACKING AND PACKAGING

Seller's prices for Goods include Seller's standard commercial packing and packaging. Any non-standard or special packing or packaging requirements requested by Buyer will be provided by Seller at additional cost to Buyer.

9. INSPECTION AND TESTS

All Goods manufactured by Seller are subject to Seller's standard inspection processes and, if applicable, acceptance testing at Seller's facility. Any additional requirements, including, without limitation, Buyer's source inspection or additional testing, are at Buyer's sole expense. If Seller and Buyer agree that Buyer is to inspect or provide for inspection at the place of manufacture, such inspection may not interfere unreasonably with Seller's operations and the Buyer's approval or rejection of Goods based on such source inspection and/or testing must be made prior to shipment of the Goods.

10. EXPORT COMPLIANCE; FOREIGN CORRUPT PRACTICES ACT
For any resale, export, or re-export of the Goods, Buyer must comply with all applicable export regulations, export licensing requirements, and the United States Foreign Corrupt Practices Act (FCPA), 15 U.S.C. ¤¤ 78dd1 through 78dd3, as amended.

11. DELIVERY SCHEDULES AND FORCE MAJEURE
Shipping dates are approximate and require prompt receipt of all necessary Buyer-furnished information and material if applicable.

Seller is not liable for any damages, re-procurement costs, or penalties related to late deliveries. Without limiting the generality of the foregoing, Seller is not liable for delays due to force majeure, including, but not limited to, weather conditions, acts of God, acts of civil or military authorities, fires, strikes, job actions, floods, earthquakes, epidemics, quarantine restriction, war, terrorism, riot, supplier or vendor delays, or any other causes beyond the reasonable control of Seller. In the event of such delay, Seller will promptly notify Buyer and the date(s) of delivery will be deferred for a period commensurate with the time lost due to the delay. If the excusable delay under force majeure continues for more than ninety (90) days, Seller and Buyer will each have the option of terminating the affected Order(s) under Article 12, Termination for Convenience. If Seller's production is curtailed for any of the above reasons so that Seller is unable to deliver the full quantity of Goods scheduled for delivery to Buyer, Seller may allocate deliveries of available Goods among its various customers then under order for similar Goods. The allocation will be made in a commercially fair and reasonable manner. When such allocation has been made, Buyer will be notified of the estimated quota made available.

12. TERMINATION FOR CONVENIENCE
Buyer may request to terminate Buyer's Order for convenience in whole or in part and Seller agrees to cooperate with Buyer in attempting to make such arrangements conditioned on Buyer paying Seller for all deliveries made and for all work in process, including all applicable direct and indirect costs, settlements with suppliers, and related administrative, accounting, and legal costs, plus a normal profit. To the extent possible, Seller will use reasonable commercial efforts to divert materials and work in process from Buyer's Order to other customers' orders in order to minimize Buyer's termination costs.

13. TERMINATION FOR DEFAULT
Either Party may terminate the Order if the other Party breaches a material provision of this Agreement or of the Order. In the event that a Party (the "Defaulting Party") is in breach of a material provision of this Agreement or the Order, the other Party (the "Non-Defaulting Party") will submit a written cure notice to the Defaulting Party advising of such breach. The Defaulting Party will have five (5) days to cure the breach. If the Defaulting Party does not cure the breach within the five (5) day period, the Non-Defaulting Party may terminate the Order.

14. CHANGES ORDERS AND AMENDMENTS
All change order requests must be submitted by the Buyer to the Seller in writing and will not be effective unless and until Seller consents in writing to the change. Seller will advise Buyer in writing of the price and/or delivery schedule impact, if any, of the change request. Seller's acceptance of changes will be subject to Buyer's agreement to any price and/or delivery schedule adjustments.

15. LIMITED WARRANTY
Seller warrants that the Goods delivered under Buyer's Order will be free from defects in material and workmanship for a period of twelve (12) months from the date of original shipment, except for components and consumables that have shorter third party manufacturer's warranty periods. Components and consumables manufactured by third parties bear the warranty of their manufacturer.

The specific warranty for a given product is the one in effect on the date of shipment. In the event that Buyer identifies any defects in material or workmanship, Buyer will promptly notify Seller of the defective Goods and the specific nature of the defect in accordance with Article 16, Return Authorizations.

Seller, at its sole discretion, will either repair or replace any such Goods found by Seller to be defective. Seller's warranty does not apply to any Goods that have been subjected to improper installation, misuse, alteration, repair, neglect, accident, inundation, fire, or the like.

THESE EXPRESS WARRANTIES, INCLUDING REMEDIES, ARE EXCLUSIVE AND ARE IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS INTENDED OR GIVEN. IN THE CASE OF GOODS OTHER THAN THOSE OF SELLER'S OWN MANUFACTURE, SELLER MAKES NO WARRANTIES, EXPRESS, STATUTORY, OR IMPLIED.

16. RETURN AUTHORIZATIONS
Buyer will promptly notify Seller of any nonconformance(s) in the Goods and afford Seller a reasonable opportunity to inspect the Goods. No Goods may be returned without Seller's prior authorization, as evidenced by a return authorization. Once a return authorization number is obtained, Buyer will return defective Goods transportation and insurance prepaid in accordance with instructions issued by Seller. Failure to follow Seller's return procedures may result in lost Goods, delays, additional service, restocking charges, warranty denial, or refusal of a shipment. The return authorization number must appear on the shipping label along with all paperwork associated with the return. Seller has the right to reject Goods returned without the correct return authorization number clearly marked on the outside of the shipping container. Granting a return authorization number does not necessarily mean that a credit will be approved or that the evaluation or repair will take place without a fee.

17. INDEMNIFICATION
Each Party (the "Indemnifying Party") will hold harmless and indemnify the other Party (the "Indeminitee") against all claims, judgments, costs, and fees, including attorney fees, relating to infringement of U.S. patents, designs, copyrights, or trademarks to the extent that the infringing Goods are manufactured, sold, or used in whole or in part to the Indemnifying Party's specifications, designs, drawings, or other technical data.

To the extent that one Party's employees or agents enter on the property owned or controlled by the other Party, the first Party will indemnify and hold harmless the other Party, its officers, directors, and employees for any property damage or bodily injury or death caused by the first Party's employees or agents.

18. LIMITATION OF LIABILITY

NOTWITHSTANDING ANY OTHER PROVISIONS OF THIS AGREEMENT, UNDER NO CIRCUMSTANCES IS EITHER PARTY LIABLE FOR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL, INDIRECT, MULTIPLE, ADMINISTRATIVE, OR PUNITIVE DAMAGES, OR ANY DAMAGE OF AN INDIRECT OR CONSEQUENTIAL NATURE ARISING OUT OF OR RELATED TO ITS PERFORMANCE UNDER THIS AGREEMENT, WHETHER BASED UPON BREACH OF THIS AGREEMENT, WARRANTY, OR NEGLIGENCE AND WHETHER GROUNDED IN TORT, CONTRACT, CIVIL LAW, OR OTHER THEORIES OF LIABILITY, INCLUDING STRICT LIABILITY, EVEN IF ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SELLER'S TOTAL LIABILITY INCLUDING, BUT NOT LIMITED TO, LIABILITY FOR INDEMNITY, DEFENSE, AND HOLD HARMLESS OBLIGATIONS IS LIMITED TO NO MORE THAN THE AMOUNT PAID TO SELLER UNDER BUYER'S ORDER AND BUYER AGREES TO INDEMNIFY SELLER FOR ANY EXCESS AMOUNTS. TO THE EXTENT THAT THIS LIMITATION OF LIABILITY CONFLICTS WITH ANY OTHER PROVISION(S) OF THIS AGREEMENT, SUCH PROVISION(S) WILL BE REGARDED AS AMENDED TO WHATEVER EXTENT REQUIRED TO MAKE SUCH PROVISION(S) CONSISTENT WITH THIS PROVISION.

19. ARBITRATION AND LAW

Disputes that arise under this Agreement or Buyer's Order that cannot be settled amicably by the Parties will be settled by arbitration in San Diego, CA in the United States of America under the prevailing rules of the commercial conciliation and arbitration rules of the American Arbitration Association. Judgment upon the arbitration award or decision may be entered in any court of competent jurisdiction. Arbitration awards and decisions are subject to Article 18, Limitation of Liability.

The laws of the State of [, excluding its conflicts of laws provisions and excluding the United Nations Convention on the International Sale of Goods ("CISG"), govern the interpretation and enforcement of this Agreement and Buyer's Order.

20. ASSIGNMENT

Buyer may not assign or transfer this Agreement or any Order, in whole or in part, without the prior written approval of Seller.

21. ETHICS AND VALUES

Seller is committed to uncompromising ethical standards, strict adherence to law, and customer satisfaction. Buyer is encouraged to communicate any concerns or questions regarding the ethics and value to the Teledyne Corporate Ethics Help Line, "Take the Right Action", at 1-877-666-6968.

22. UNENFORCEABLE PROVISIONS

In the event that one or more provisions of this Agreement document is held to be unenforceable, the remaining provisions apply in full and the invalid or unenforceable provision will be replaced by a provision that lawfully enforces the Parties' intention underlying the invalid or unenforceable provision.

23. SURVIVAL

The following Article will survive the termination or expiration of this Agreement or any Order: 1: Definitions; 4: Credit Approval and Payment; 5: Taxes; 6: Shipping Terms and Risk of Loss; 7: Tooling; 9: Inspection and Tests; 10: Export Compliance; Foreign Corrupt Practices Act; 11: Delivery Schedules and Force Majeure; 12: Termination for Convenience; 13: Termination for Default; 15: Limited Warranty; 17: Indemnification; 18: Limitation of Liability; 19: Arbitration and Law; 20: Assignment; 22: Unenforceable Provisions; and 23: Survival.

24. WHOLE AGREEMENT; AMENDMENT

This document is the entire understanding between the Parties, and it supersedes all previous or additional agreements, arrangements, and drafts. This document may be amended or modified only by written agreement of duly authorized representatives of both Parties.

Revision February 27, 2008

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00041**
For:	Bottom Pressure/Tilt
Type:	Budgetary Quote / email
Date:	6 Oct 2008
Company:	PI mix of commercial (Paroscientific & LILY)
Requested By:	DSK, SD

Notes: $60K
.

BPR-Tilt

NOTE: Chadwick notes in his proposal that they estimate that they can build the BPR/Tilts for $60K ea.

Date: Sat, 06 Oct 2007 17:12:38 -0700
From: Bill Chadwick <William.W.Chadwick@noaa.gov>
To: dskelley@u.washington.edu
Subject: Re: BPR/Tilt

Deb -
It's probably closer to $50K including the connector, but let me check again with our engineers before you put that in. Might depend if the tilt sensor is included or not. I'll get back to you on Monday. You heard my proposal didn't get funded, didn't you? Would the "core" instruments include BPRs at all 6 nodes at Axial, or just one BPR for the Axial node as a whole? I have no idea what is being considered as "core" sensors - and I'm assuming that would mean they would be paid for up front?
-Bill

APPLIED GEOMECHANICS
A DIVISION OF PINNACLE TECHNOLOGIES

Quotation

Purcahse 10 LILY Self-Leveling Borehole Tiltmeters with unit prices for alternatives and accessories

Proposal Date: 9/30/2008 **Customer:** Gerald (Skip) Denny **Ship Date:**

Proposal No.: Q-08-1441 **Ph:** 206 543-8042 **Ship Via:**

Fx:

Terms: Credit Card, Cash in Advance or Net 30 Days on Approved Credit

Bill To:

Applied Physics Lab

University of Washingtom
1013 NE 40th Street

Seattle, WA 98105

United States

Ship To:

Applied Physics Lab

University of Washingtom
1013 NE 40th Street

Seattle, WA 98105

United States

Item	Model No.	Description	Qty	Unit Price	Line Total
1	LILY 485	"LILY" Self-Leveling Geodetic Borehole Tiltmeter, +/-10 deg leveling range, RS485 output	10	$8,500.00	$85,000.00
2	LILY 232	"LILY" Self-Leveling Geodetic Borehole Tiltmeter, +/-10 deg leveling range, RS232 output	TBD	$8,650.00	TBD
3	LILY 485/232	"LILY" Self-Leveling Geodetic Borehole Tiltmeter, +/-10 deg leveling range, RS485 + RS232 output	TBD	$8,800.00	TBD
4	89079-01	LILY Starter Kit: 20 ft test cable with connectors and 100-240 VAC power transformer, for LILY version 98020-01 (RS485)	TBD	$425.00	TBD
5	89079-02	LILY Starter Kit: 20 ft test cable with connectors and 100-240 VAC power transformer, for LILY version 98020-02 (RS232)	TBD	$425.00	TBD
6	89079-03	LILY Starter Kit: 20 ft test cable, connectors & 100-240 VAC power transformer, for LILY version 98020-03 (RS485+RS232)	TBD	$497.00	TBD
7	89072	"LILY" Test Cable, RS485, with 6-contact neoprene connector on tiltmeter end, DB9 and power jack on far end, 6m (20 ft)	TBD	$375.00	TBD
8	89078	"LILY" Test Cable, RS232, with 6-contact neoprene connector on tiltmeter end, DB9 and power jack on far end, 6m (20 ft)	TBD	$375.00	TBD
9	89070	"LILY" Test Cable, RS232 + RS485, 8-contact connector on tiltmeter end, power jack and 2 DB9 on far end, 6m (20 ft)	TBD	$450.00	TBD
10	70304-E	Tiltmeter Cable, 10 Conductors, PVC Jacket, Polypropylene Insulation (price per ft)	TBD	$0.70	TBD

NOTES:

1. Shipment: Shipment 6-8 weeks ARO
2. Values are in U.S. Dollars, FOB Factory, and are good for 60 days.
3. Our General Terms and Conditions of Sale shall apply to this order.

Subtotal	*$85,000.00*
Freight + Insurance	*TBD*
Sales Tax	*$0.00*
Total Quote	*$85,000.00*

Applied Geomechanics
140 Chestnut Street San Francisco, CA 94111- USA
Phone: (415) 364-3200 Fax: (415) 861-1448
www.geomechanics.com applied@geomechanics.com

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00042**
For:	Pressure sensor
Type:	Budgetary Quote / email
Date:	17 July 2008
Company:	Paroscientific
Requested By:	SD

Notes: will need to be combined with tilt sensors for some uses.

Paroscientific,Inc.
4500 148th Avenue N. E.
Redmond, WA 98052-5194
Telephone: (425) 883-8700
Facsimile: (425) 867-5407
Email: smith@paroscientific.com
Internet:http://www.paroscientific.com

July 18, 2008

University of Washington
Applied Physics Lab
1013 NE 40th St.
Seattle, WA 98105

Attention: Skip Denny
Phone: (206) 543-8042
denny@apl.washington.edu

Subject: Request for Quotation – Paroscientific Digiquartz® Intelligent Depth Sensor
Reference: Telecom of Today

Dear Skip,

Thank you for your interest in Paroscientific Precision Pressure Products. We are pleased to provide the following quotation in response to our reference telephone conversation:

Item	Qty	Model, P/N (SCD)	Description	Unit Price
1	1	Model 8CB4000-I P/N 1700-003-0 SCD 7613-001 Rev E (Copy Attached)	Digiquartz® Intelligent Depth Sensor, Range 0-4,000 Meters (0-6,000 PSIA Range), RS-232/RS-485 Bi-Directional Interface, Electrically Isolated, Stainless Steel Housing, Oil-Filled.	$ 6,995.00
2	1	Model 8B4000-I P/N 1283-001-0 SCD 7502-001 Rev L (Copy Attached)	Digiquartz® Intelligent Depth Sensor, Range 0-4000 Meters (0-6,000 PSIA Range), RS-232 Bi-Directional Interface, Stainless Steel Housing, Electrically Isolated, Oil-Filled.	$ 7,195.00

Notes:
-Quote No: 071808SS-AW.
-Paroscientific, Inc.'s Terms and Conditions* of Sale apply
-Delivery: Shipment 10 weeks ARO, subject to prior sale.
-Quote valid 30 days from date of quotation.
-Payment Terms: Net 30 Days upon approval of credit
-FOB Redmond, WA, USA.
-Digiquartz® "Intelligent" products include our CD/ROM Library of M/S Windows-based software for ease in product configuration, diagnostics, and data acquisition.
-Transducers include a 5-Year Extended Limited Warranty* (first 2-years at no charge).
-Barometers include a 3-Year Extended Warranty for long-term stability, and a free NIST traceable recalibration within 2-years of purchase.
-Free zero adjustment and a new certificate of traceability for all Digiquartz® absolute transducers, transmitters and portable standards with full-scale pressure ranges of 500 psia or less within the first two years of shipment.
*copies available for review at our Internet Web Site: http://www.paroscientific.com.

If you have any questions, please feel free to contact me. We look forward to your business.

Sincerely,
Paroscientific, Inc.

Steve Smith
Sales & Applications
Attachments: (2)

Digiquartz® Technology

Precision Pressure Instrumentation

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00043**
For:	HD Camera
Type:	Budgetary Quote / email
Date:	1 April 2008
Company:	Insite Tritech
Requested By:	SD

Notes: may be able to use mini-Zeus vs Zeus

From: Tom Olkowski [tom@insitetritech.com]
Sent: Tuesday, April 01, 2008 10:14 AM
To: Skip Denny
Subject: Re: Zeus Plus info

Attachments: Mini Zeus datasheet.pdf

Hi Skip,

The current price for the Zeus Plus with full wave division multiplexing and Fiber optic interface for 6,000 meter depth is about $140,000.00

We have a new MINI ZEUS camera that is now available.
The camera has fully corrected optics but does not have quite the video quality or optics as the Zeus Plus.
But it is a lot smaller in size and the price is a lot less.
Please see the attached data sheet.
The price is $19,990.00 in a 4KM titanium housing with component video out only.
With Fiber optic interface it is more expensive and I have not quite finished pricing this option.

Best regards,
Tom Olkowski

Insite Pacific Inc.
742 Genevieve Street, Suite T
Solana Beach, CA 92075
Phone# (858) 523-0642
Fax# (858) 523-0643

----- Original Message -----
From: Skip Denny
To: Tom@insitetritech.com
Sent: Monday, March 31, 2008 2:56 PM
Subject: Zeus Plus info

Hi,

Can I get technical information on the Zeus Plus Color HD camera? We're trying to scope the power/size/installation requirements of the proposed core instruments on the cabled observatory now known as OOI/RSN (formerly Neptune and RCO) on the Juan de Fuca plate. These would be mounted in less than 3000m water. Is there any electrical connection to the case as we might be using a sea water return for some of the power? I would assume there is a pan/tilt platform? Are there unique mounting requirements?

Thanks for your time.

Skip Denny
Senior Engineer
206 543-8042

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00044**
For:	Short Period Seismometer
Type:	Budgetary Quote / email
Date:	17 July 2008
Company:	Metrozet
Requested By:	SD

Notes:

From: thomasvanzandt@gmail.com on behalf of Tom VanZandt (Metrozet LLC) [tom.vanzandt@metrozet.com]
Sent: Friday, July 18, 2008 10:35 AM
To: Skip Denny
Cc: Stephen Manion; Eric Canuteson
Subject: Re: Metrozet Sales Inquiry

Hi Skip,

My rough guess is that a titanium housing for the sensor might cost on the order $8K, possibly a bit more if we try to replicate the MBARI leveling sensor scheme (with optical feedback via LEDs).

It might make sense to enlarge (at least one end) of the sensor package a bit so as to be able to include the DR-2 recorder in it. This will save quite a bit, including the cost of connectors. The DR-2 has no moving parts (unlike the LP-1 which needed to be remotely sited) and we have used it in tightly integrated packages in very high sensitivity short period seismic applications. Perhaps a single package for both sensor and recorder would be ~$10K.

I believe that MBARI has had a good deal of success with Nautilus connectors. However, their deployments involved hot plugging to the sensors via an ROV. If we integrated things fully, then we might not need this functionality. Also, the pinouts of the integrated system could be much simpler (less conductors).

Tom

On Fri, Jul 18, 2008 at 8:09 AM, Skip Denny <denny@apl.washington.edu> wrote:

Hi Tom,

Thanks for the good info. The system will have up to 48 Vdc (regulated) available for powering and anything from Rs-232 to Ethernet IP addresses. There's a concern about Benthos spheres because of the possible use of Alvin for work around the sites, so we're pretty much looking at SS or Titanium housings. Any idea of cost there? Any preference on connectors? Those costly little jewels will be raising their head soon. Onboard data storage could become a Navy issue – not resolved, yet.

Many thanks,

Skip Denny

From: thomasvanzandt@gmail.com [mailto:thomasvanzandt@gmail.com] On Behalf Of Tom VanZandt (Metrozet LLC)
Sent: Thursday, July 17, 2008 5:08 PM
To: Skip Denny
Cc: Stephen Manion; Eric Canuteson
Subject: Re: Metrozet Sales Inquiry

Hi Skip,

Our oceanographic seismic instrumentation is still available, but you are correct in the fact that they are custom built systems at present. We would be happy to provide a quantity of 7 sensors and recorders. In the interest of fostering further discussion, let me give you an overview of these products in their current form:

1. BH-1 Short Period Sensor. This remains unchanged. It is a small, triaxial, force balance sensor package that provides a transfer function similar to a larger, 1 Hz geophone. This is the same sensor that has been deployed for years on the Juan de Fuca Ridge. We provide an unpackaged sensor that is designed to be bolted to the endcap of a cylindrical, titanium pressure vessel. Each sensor is shake table tested prior to delivery. The cost of this sensor is $11K.
2. Past deployments of the BH-1 utilized a custom, titanium pressure vessel/optical level indicator package (for leveling in situ) that was manufactured by MBARI. I have discussed acquiring this design with them and I believe that we could get it from them. This is something that we would be willing to provide under the auspices of a volume order. Alternatively, MBARI may be interested in supplying these themselves. Paul McGill is the MBARI point-of-contact.
3. Metrozet has upgraded its data recorder technology (to the DR-2). We currently have a high resolution recording system (24 bit recorder), with flexible timing options, and a very large amount (i.e., 10's of GB) of FLASH data storage. The unit can operate from an external PPS signal or it can provide standalone timing with periodic re-synchronization. The recorder currently is configured for RS-485 communications, however, it would be very simple to modify this for other formats (such as RS-232). They are a set of character string commands for controlling the recorder externally and for initiating near-real-time data streaming. It currently accepts 48V input power. This system is used within a proprietary land seismic acquisition system that the company currently sells and supports. Again, the design is fairly flexible and we are quite willing work with you to modify it as needed for your application. The unit cost of this system is $10K. We believe that this represents a very significant enhancement over the LP-1.
4. The DR-2 (like the LP-1) comes as an unpackaged system. In the past, the recording system was housed inside of Benthos spheres. While simple and relatively economical, this approach may have some limitations. Metrozet would be willing to develop appropriate packaging for deep ocean applications. This effort could be combined with the packaging task in item 2 above, given a volume order.

I am happy to explore any particular options with you on this. Feel free to give me a call if you require any additional information.

Thanks.

Tom VanZandt

On Thu, Jul 17, 2008 at 3:36 PM, Skip Denny <denny@apl.washington.edu> wrote:

Hi,

I'm an engineer working on the OOI-RSN. The oceanography side has indicated we will need ~7 more MBARI/GEOSense BH1 3-axis corehole geophone with LP1 data logger. Not seeing that on your website, I presume it's either a specialty or obsolete. We want to measure short period seismic waves at a couple of sites that are off the Oregon/Washington coast varying in depth from 3000 to 1800m deep. They will be connected to the observatory for power and communications (data and commands – we'll have 1GigE available down to RS-232) via our 1400 km of telecom cable with fiberoptics. With an upcoming program review that would like updated costs, what device(s) am I looking at and how much?

Thanks,

Skip Denny

Senior Engineer

206 543-8042

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****
Tom VanZandt
tom.vanzandt@metrozet.com
(310) 294-3724
(866) 823-0339

WWW.METROZET.COM
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Tom VanZandt

tom.vanzandt@metrozet.com
(310) 294-3724
(866) 823-0339

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****

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00047**
For:	Broadband Seismometers
Type:	Budgetary Quote / email
Date:	6 Oct 2008
Company:	Guralp & Keck/Guralp
Requested By:	DSK, SD

Notes: Quote requested from Guralp, but not received as of 5 Nov
Attached comments re:Keck BB Seismometers.
Metrozet is being funded by NSF to develop BB Seis now.

Blanco Seismometers
Date: Tue, 9 Oct 2007 11:33:45 -0400
From: jmcguire@whoi.edu
To: dskelley@u.washington.edu
Subject: Re: Blanco Sensors

Hi Deb,

There are currently 10 Keck OBSs. They have a Guralp CMG-3T broadband seismometer and a Episensor Accelerometer on them. They also have a scripps hydrophone (Differential Pressure Gauge) that is tuned for long periods (e.g. seismic surface waves) not what the Navy is typically worried about. There could also be additional tsunami detector pressure gauges in the future.

As for conversion costs, it's pretty hard to even guess a #. It depends on wether there is: A) money available for titanium pressure housings so the obss last the duration of the RCO, B) a mandate from cyberinfrastructure to add a Marmot data accumulator to the system that would dramatically increase the size/cost of the pressure housing (e.g. build new ones), C) timing and power conversion boards maybe neccessary, D) a bunch of smaller cost stuff like cables so the accelerometers can be buried, the release/ frames modified. for ease of ROV manipulation, etc. So it's hard to imagine doing all of those for only $30k, so it depends what is really required to be an RCO compatabile instrument. For instance, upgrading to titanium seems like a nobrainer given the cost of ROV servicing if something goes wrong. If items A and B are required then the cost could easily double.

As another note, in thinking about all of this, it is likely that it may be more financially efficient to build new sensors that are optimized for the cable with that change over money. Particularly if the secondary infrastructure is only going to cover a small portion of the expected rupture areas (e.g. our other email discussion). The Keck instruments have lots of extra stuff (double releases, lots of flotation, big frames, lots of cables/penetrators, etc) that isn't neccessary for a cabled instrument. For instance if $400k were available for change overs, it's likely that we could get ~5+ new systems that are optimized for cabled deployment and still have the 10 keck ones to deploy campaign style to expand the footprint (and avoid the embarassment of missing the first big quake). Anyway, food for future thought. Either way its good to keep some changeover funds in the budget.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00048**
For:	Fluorometer BB2F
Type:	Budgetary Quote / email
Date:	24 Oct 2008
Company:	WETLabs, Inc.
Requested By:	SD

Notes: look at 2 wavelength in sheet.

PO Box 518
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Philomath OR 97370

(541) 929-5650
Fax (541) 929-5277
http://www.wetlabs.com

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• Returns of unused merchandise subject to 20% restocking fee • FOB Philomath, OR

Customer Commitment Statement

WET Labs commits to excellence in the products and services it provides. We will provide products defined by innovative design, high quality manufacture and outstanding value. Our service will be prompt, friendly and efficient. Your satisfaction as a customer is our goal.

ECO Series

Model	Price	Description	Specific Instrument
		Single Channel Backscattering Meter	
bbrt	$3,125	ECO Backscattering meter, real time	BBRT Blue
			BBRT Green
			BBRT Red
bbrtd	$4,000	ECO Backscattering meter (6000 m)	BBD Blue
			BBD Green
			BBD Red
bbb	$4,750	ECO Backscattering meter, batteries, memory	BBB Blue
			BBB Green
			BBB Red
bbs	$5,625	ECO Backscattering meter, Bio-wiper, memory	BBS Blue
			BBS Green
			BBS Red
bbsb	$6,625	ECO Backscattering meter, batteries, memory, Bio-wiper	BBSB Blue
			BBSB Green
			BBSB Red
		Single Channel Turbidity Meter	
NTUrt	$2,750	ECO Turbidity meter, real-time	NTURT
NTUrtd	$3,750	ECO Turbidity meter (6000 m)	NTURTD
NTUb	$4,375	ECO Turbidity meter, batteries, memory	NTUb
NTUs	$5,250	ECO Turbidity meter, Bio-wiper, memory	NTUS
NTUsb	$6,250	ECO Turbidity meter, batteries, memory, Bio-wiper	NTUSB
		Single Channel Chlorophyll Fluorometer	
FLrt	$3,750	ECO Chlorophyll fluorometer, real-time	FLRT
FLrtd	$4,750	ECO Chlorophyll fluorometer (6000 m)	FLRTD
FLb	$5,375	ECO Chlorophyll fluorometer, batteries, memory	FLB
FLs	$6,250	ECO Chlorophyll fluorometer, Bio-wiper, memory	FLS
FLsb	$7,250	ECO Chlorophyll fluorometer, batteries, memory, Bio-wiper	FLSB
		Single Channel CDOM Fluorometer	
Cdrt	$4,500	ECO CDOM fluorometer, real-time	FLCDRT
Cdrtd	$5,625	ECO CDOM fluorometer (6000 m)	FLCDRTD
Cdb	$6,125	ECO CDOM fluorometer, batteries, memory	FLCDB
Cds	$7,000	ECO CDOM fluorometer, Bio-wiper, memory	FLCDS
Cdsb	$8,000	ECO CDOM fluorometer, batteries, memory, Bio-wiper	FLCDSB

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Fax (541) 929-5277
http://www.wetlabs.com

Model	Price	Description	Specific Instrument
		Single Channel Phycocyanin Fluorometer	
PCrt	$4,750	ECO Phycocyanin fluorometer, real-time	PCRT
PCb	$6,375	ECO Phycocyanin fluorometer, batteries, memory	PCB
PCs	$7,250	ECO Phycocyanin fluorometer, Bio-wiper, memory	PCS
PCsb	$8,250	ECO Phycocyanin fluorometer, batteries, memory, Bio-wiper	PCSB
		Single Channel Phycoerythrin Fluorometer	
PErt	$4,750	ECO Phycoerythrin fluorometer, real-time	PERT
PEb	$6,375	ECO Phycoerythrin fluorometer, batteries, memory	PEB
PEs	$7,250	ECO Phycoerythrin fluorometer, Bio-wiper, memory	PES
PEsb	$8,250	ECO Phycoerythrin fluorometer, batteries, memory, Bio-wiper	PESB
		Single Channel Rhodamine Dye Fluorometer	
Rhrt	$4,750	ECO Rhodamine fluorometer, real-time	RHRT
Rhb	$6,375	ECO Rhodamine fluorometer, batteries, memory	RHB
Rhs	$7,250	ECO Rhodamine fluorometer, Bio-wiper, memory	RHS
Rhsb	$8,250	ECO Rhodamine fluorometer, batteries, memory, Bio-wiper	RHSB
		Single Channel Uranine/Fluorescein Dye Fluorometer	
Urrt	$4,750	ECO Uranine/Fluorescein fluorometer, real-time	URRT
Urb	$6,375	ECO Uranine/Fluorescein fluorometer, batteries, memory	URB
Urs	$7,250	ECO Uranine/Fluorescein fluorometer, Bio-wiper, memory	URS
Ursb	$8,250	ECO Uranine/Fluorescein fluorometer, batteries, memory, Bio-wiper	URSB
		Dual Channel ECO	
Flnturt	$4,500	ECO Chlorophyll fluorometer, turbidity meter, real time	FLNTURT
Flnturtd	$5,625	ECO Chlorophyll fluorometer, turbidity meter (6000 m)	FLNTUD
Flntub	$6,125	ECO Chlorophyll fluorometer, turbidity meter, batteries, memory	FLNTUB
Flntus	$7,000	ECO Chlorophyll fluorometer, turbidity meter, Bio-wiper, memory	FLNTUS
Flntusb	$8,000	ECO Chlorophyll fluorometer, turbidity meter, batteries, memory, Bio-wiper	FLNTUSB
		ECO Flntu's are available in three ranges. Resolutions are approximate	
		0 - 30 μg Chl/l 0-10 NTU Resolution: 0.008 μg Chl/l 0.003 NTU	
		0 - 50-ug Chl/l 0-25 NTU Resolution: 0.013 μg Chl/l 0.007 NTU	
		0 - 125 ug Chl/l 0-1000 NTU Resolution: 0.03 μg Chl/l 0.25 NTU	
		Three Channel ECO	
trip	$8,750	ECO Custom Triplet	
		Please contact WET Labs for specific combinations	BB3
		Triplets are serial output only and include internal memory	BB2FL
			BBFL2
			FL3
tripb	$9,750	ECO Custom Triplet, Batteries	
		Please contact WET Labs for specific combinations	BB3B
			BB2FLB
			BBFL2B
			FL3B

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Philomath OR 97370

(541) 929-5650
Fax (541) 929-5277
http://www.wetlabs.com

Model	Price	Description	Specific Instrument
		ECO Multi-angle scattering sensors	
vsf	$6,250	ECO Three-angle Backscattering Meter	VSF BLUE
			VSF GREEN
			VSF RED
vsfb	$7,250	ECO Three-angle Backscattering Meter batteries, memory	VSFB BLUE
			VSFB GREEN
			VSFB RED
vsfs	$9,750	ECO Three-angle Backscattering Meter, Bio-wiper, memory	VSFS BLUE
			VSFS GREEN
			VSFS RED
vsfsb	$10,750	ECO Three-angle Backscattering Meter, batteries, Bio-wiper, memory	VSFSB BLUE
			VSFSB GREEN
			VSFSB RED
		ECO Multi-head ECO	
vsf3	$23,750	ECO Three-angle, three wavelength backscattering meter (Red, Green, Blue)	VSF3
bb9	$23,750	ECO Nine wavelength backscattering meter	BB9
bb9	$26,250	ECO Custom bb9 (check with WL for available wavelengths)	BB9
bb9f	$26,250	ECO Custom bb9 w/ Chl and CDOM fluorometer channels bb9 wavelengths: 412, 440, 488, 510, 532, 595, 650, 676, 715 nm	BB7FL2
		ECO options and spare parts	
220259	$625	ECO temperature sensor (not available on real time (rt) units)	ECO thermistor
BP357 CL	$2,000	ECO pressure sensor (not available on rt units) Contact WL for ranges	e.g. 0 – 600 meters
811005	$250	ECO Copper face plate (for instruments without a Bio-wiper)	Copper face plate
	$300	ECO Custom calibration (e.g. backscattering calibration on Flntu)	Custom calibration
0 channel	$350	ECO Triplet bench test cable, serial output only (DB9)	ECO host cable - serial
1 channel	$350	ECO FL bench test cable, serial output and one analog connector	ECO host cable - serial, analog
2 channel	$350	ECO FLNTU bench test cable, serial output and two analog connectors	ECO host cable -serial, 2 analog
210209	$80	ECO jumper plug for battery units	3 pin male dummy plug switch
MCDC6 FS	$40	Dummy plug for six pin bulkhead	6 pin female dummy plug
MCDC-3-MP	$40	Dummy plug for three pin battery bulkhead	3 pin male dummy plug
220529	$100	Bio-wiper	Bio-wiper
100176	$100	ECO mounting clamp	ECO mounting clamp
220088	$25	ECO end mounting bracket	End mounting bracket
220051	$40	Protective end cap	End cap

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00049**
For:	Fluorometer 3W
Type:	Budgetary Quote / email
Date:	24 Oct 2008
Company:	WETLabs, Inc.
Requested By:	SD

Notes: look at 3 wavelength sensors in sheet.

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ECO Series

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		Single Channel Backscattering Meter	
bbrt	$3,125	ECO Backscattering meter, real time	BBRT Blue
			BBRT Green
			BBRT Red
bbrtd	$4,000	ECO Backscattering meter (6000 m)	BBD Blue
			BBD Green
			BBD Red
bbb	$4,750	ECO Backscattering meter, batteries, memory	BBB Blue
			BBB Green
			BBB Red
bbs	$5,625	ECO Backscattering meter, Bio-wiper, memory	BBS Blue
			BBS Green
			BBS Red
bbsb	$6,625	ECO Backscattering meter, batteries, memory, Bio-wiper	BBSB Blue
			BBSB Green
			BBSB Red
		Single Channel Turbidity Meter	
NTUrt	$2,750	ECO Turbidity meter, real-time	NTURT
NTUrtd	$3,750	ECO Turbidity meter (6000 m)	NTURTD
NTUb	$4,375	ECO Turbidity meter, batteries, memory	NTUb
NTUs	$5,250	ECO Turbidity meter, Bio-wiper, memory	NTUS
NTUsb	$6,250	ECO Turbidity meter, batteries, memory, Bio-wiper	NTUSB
		Single Channel Chlorophyll Fluorometer	
FLrt	$3,750	ECO Chlorophyll fluorometer, real-time	FLRT
FLrtd	$4,750	ECO Chlorophyll fluorometer (6000 m)	FLRTD
FLb	$5,375	ECO Chlorophyll fluorometer, batteries, memory	FLB
FLs	$6,250	ECO Chlorophyll fluorometer, Bio-wiper, memory	FLS
FLsb	$7,250	ECO Chlorophyll fluorometer, batteries, memory, Bio-wiper	FLSB
		Single Channel CDOM Fluorometer	
Cdrt	$4,500	ECO CDOM fluorometer, real-time	FLCDRT
Cdrtd	$5,625	ECO CDOM fluorometer (6000 m)	FLCDRTD
Cdb	$6,125	ECO CDOM fluorometer, batteries, memory	FLCDB
Cds	$7,000	ECO CDOM fluorometer, Bio-wiper, memory	FLCDS
Cdsb	$8,000	ECO CDOM fluorometer, batteries, memory, Bio-wiper	FLCDSB

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PCrt	$4,750	ECO Phycocyanin fluorometer, real-time	PCRT
PCb	$6,375	ECO Phycocyanin fluorometer, batteries, memory	PCB
PCs	$7,250	ECO Phycocyanin fluorometer, Bio-wiper, memory	PCS
PCsb	$8,250	ECO Phycocyanin fluorometer, batteries, memory, Bio-wiper	PCSB
		Single Channel Phycoerythrin Fluorometer	
PErt	$4,750	ECO Phycoerythrin fluorometer, real-time	PERT
PEb	$6,375	ECO Phycoerythrin fluorometer, batteries, memory	PEB
PEs	$7,250	ECO Phycoerythrin fluorometer, Bio-wiper, memory	PES
PEsb	$8,250	ECO Phycoerythrin fluorometer, batteries, memory, Bio-wiper	PESB
		Single Channel Rhodamine Dye Fluorometer	
Rhrt	$4,750	ECO Rhodamine fluorometer, real-time	RHRT
Rhb	$6,375	ECO Rhodamine fluorometer, batteries, memory	RHB
Rhs	$7,250	ECO Rhodamine fluorometer, Bio-wiper, memory	RHS
Rhsb	$8,250	ECO Rhodamine fluorometer, batteries, memory, Bio-wiper	RHSB
		Single Channel Uranine/Fluorescein Dye Fluorometer	
Urrt	$4,750	ECO Uranine/Fluorescein fluorometer, real-time	URRT
Urb	$6,375	ECO Uranine/Fluorescein fluorometer, batteries, memory	URB
Urs	$7,250	ECO Uranine/Fluorescein fluorometer, Bio-wiper, memory	URS
Ursb	$8,250	ECO Uranine/Fluorescein fluorometer, batteries, memory, Bio-wiper	URSB
		Dual Channel ECO	
Flnturt	$4,500	ECO Chlorophyll fluorometer, turbidity meter, real time	FLNTURT
Flnturtd	$5,625	ECO Chlorophyll fluorometer, turbidity meter (6000 m)	FLNTUD
Flntub	$6,125	ECO Chlorophyll fluorometer, turbidity meter, batteries, memory	FLNTUB
Flntus	$7,000	ECO Chlorophyll fluorometer, turbidity meter, Bio-wiper, memory	FLNTUS
Flntusb	$8,000	ECO Chlorophyll fluorometer, turbidity meter, batteries, memory, Bio-wiper	FLNTUSB
		ECO Flntu's are available in three ranges. Resolutions are approximate	
		0 - 30 µg Chl/l 0-10 NTU Resolution: 0.008 µg Chl/l 0.003 NTU	
		0 - 50-ug Chl/l 0-25 NTU Resolution: 0.013 µg Chl/l 0.007 NTU	
		0 - 125 ug Chl/l 0-1000 NTU Resolution: 0.03 µg Chl/l 0.25 NTU	
		Three Channel ECO	
trip	$8,750	ECO Custom Triplet	
		Please contact WET Labs for specific combinations	BB3
		Triplets are serial output only and include internal memory	BB2FL
			BBFL2
			FL3
tripb	$9,750	ECO Custom Triplet, Batteries	
		Please contact WET Labs for specific combinations	BB3B
			BB2FLB
			BBFL2B
			FL3B

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		ECO Multi-angle scattering sensors	
vsf	$6,250	ECO Three-angle Backscattering Meter	VSF BLUE
			VSF GREEN
			VSF RED
vsfb	$7,250	ECO Three-angle Backscattering Meter batteries, memory	VSFB BLUE
			VSFB GREEN
			VSFB RED
vsfs	$9,750	ECO Three-angle Backscattering Meter, Bio-wiper, memory	VSFS BLUE
			VSFS GREEN
			VSFS RED
vsfsb	$10,750	ECO Three-angle Backscattering Meter, batteries, Bio-wiper, memory	VSFSB BLUE
			VSFSB GREEN
			VSFSB RED
		ECO Multi-head ECO	
vsf3	$23,750	ECO Three-angle, three wavelength backscattering meter (Red, Green, Blue)	VSF3
bb9	$23,750	ECO Nine wavelength backscattering meter	BB9
bb9	$26,250	ECO Custom bb9 (check with WL for available wavelengths)	BB9
bb9f	$26,250	ECO Custom bb9 w/ Chl and CDOM fluorometer channels bb9 wavelengths: 412, 440, 488, 510, 532, 595, 650, 676, 715 nm	BB7FL2
		ECO options and spare parts	
220259	$625	ECO temperature sensor (not available on real time (rt) units)	ECO thermistor
BP357 CL	$2,000	ECO pressure sensor (not available on rt units) Contact WL for ranges	e.g. 0 – 600 meters
811005	$250	ECO Copper face plate (for instruments without a Bio-wiper)	Copper face plate
	$300	ECO Custom calibration (e.g. backscattering calibration on Flntu)	Custom calibration
0 channel	$350	ECO Triplet bench test cable, serial output only (DB9)	ECO host cable - serial
1 channel	$350	ECO FL bench test cable, serial output and one analog connector	ECO host cable - serial, analog
2 channel	$350	ECO FLNTU bench test cable, serial output and two analog connectors	ECO host cable -serial, 2 analog
210209	$80	ECO jumper plug for battery units	3 pin male dummy plug switch
MCDC6 FS	$40	Dummy plug for six pin bulkhead	6 pin female dummy plug
MCDC-3-MP	$40	Dummy plug for three pin battery bulkhead	3 pin male dummy plug
220529	$100	Bio-wiper	Bio-wiper
100176	$100	ECO mounting clamp	ECO mounting clamp
220088	$25	ECO end mounting bracket	End mounting bracket
220051	$40	Protective end cap	End cap

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00050**
For:	HPIES
Type:	Budgetary Quote / pers. Comm..
Date:	3 June 2008
Company:	PI – Tom Sanford/Jim Carlson
Requested By:	SD

Notes: requires different IES, now from Randy Watts/URI, est.
Cost for further units: $50,000.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00051**
For:	pCO2
Type:	Budgetary Quote / email
Date:	22 Sept 2008
Company:	Sunburst Instruments
Requested By:	SD

Notes: requires reagents

From: Jim Beck [jim@sunburstsensors.com]
Sent: Monday, September 22, 2008 1:33 PM
To: Skip Denny
Subject: Re: quote

I'm not sure if I talked to anyone w/ you guys or not. There is a 1500 m version of the SAMI-pH. Instruments are currently priced at $17K for the 100 m version and $19K for 1500 m version. Mooring cages are $1400 if you need them. If you want this in formal quote let me know.

regards,
Jim

Jim Beck
jim@sunburstsensors.com

On Sep 16, 2008, at 12:47 PM, Skip Denny wrote:

I'm working on the RSN (cable observatory) segment of the OOI. We're facing a Final Design Review in November and need costs for our basis of estimates. Hopefully I'm not duplicating the Coastal/Global's efforts. If so, could you just send me a copy of their quote?

Can I get an update quote for a SAMI-1500 pCO2 sensor? Also for pH. Will you be making a pH sensor that will go to 200m?

Many thanks,

Skip Denny
Senior Engineer
206 543-8042

<Gerald (Skip) Denny (Denny@apl.washington.edu).vcf>

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00052**
For:	5-Beam ADCP
Type:	Budgetary Quote / email
Date:	19 Nov 2007
Company:	TRDI
Requested By:	Bruce Howe

Notes: 1 built and used by Anne Gargette

TELEDYNE
RD INSTRUMENTS
A Teledyne Technologies Company

Date: *November 13th, 2007*

Number of pages (incl. cover sheet)	*4*
COMPANY:	*UW APL*
ATTN:	*Bruce Howe*
Phone:	*206.543.9141*
Fax:	
Email:	*howe@apl.washington.edu*
CC:	
FROM:	*Patrick Bradley*
Phone	*858-842-2747*
Fax	

Bruce,

Thank you for your time this morning and your interest in pushing the state of the art usage of ADCPs for turbulence measurements. Please understand that this document is merely an *unofficial* estimate delivered to give you an idea of what we are planning to accomplish to satisfy your request for a 5 Beam ADCP for turbulence studies. As I mentioned earlier, I will proceed with the feasibility review process performed internally by the Teledyne RD Instruments Customs Department for a 6000m Rated and a 500m rated 5 Beam ADCP, communicating in RS232 Mode. This process may take a few weeks, but we hope to have a more accurate estimate before the end of this calendar year.

Teledyne RD Instruments 5 Beam ADCPs will provide you with the following capability:

a) RDS^3 ping synchronization capability to synchronize two sets of transducers to generate a “5 beam ADCP”.
b) Ability to quantify both the Reynolds Stress and Turbulent Kinetic Energy levels (See Table one for additional information comparing available ADCP transducer configurations for the measurements of stress and TKE)

Regards,

Patrick Bradley
Teledyne RD Instruments
(858) 413 6036 cell
(858) 842-2747 direct

WORKHORSE SERIES

Sentinel 5 x Beam 1200 kHz
Direct Reading ADCP

The WORKHORSE SENTINEL 5 Beam ADCP is designed to satisfy the needs of scientists that are interested in mixing and turbulence measurements that benefit from a direct measurement of the vertical velocity. Each system comes with one 4 beam "janus" WorkHorse transducer and electronics with a separate transducer that holds a single, "5th beam." The electronics that accompany the 5th beam are housed in a single pressure case. Both sets of electronics are able to be synchronized with standard RD3^3 technology to facilitate asynchronous sampling to avoid biased data due to acoustic interference cross talk. The system is suited for installation in an externally powered "ocean observatories" or for autonomous data collection in remote locations with external battery power. The Monitor 5x Beam supports RS-232 communications protocols, with an optional upgrade for RS422 communications. It is possible to upgrade any existing 4x beam WorkHorse ADCP with a 5th beam upgrade.

Items included in complete system:

"Janus" Transducer: Aluminum 4 beams at 30^{o} from vertical in a convex configuration, temperature sensor
"5th Beam" Transducer: Aluminum, 500 meter depth rated or 6000m rated, 1 beam, with mounting plate to fix orientation relative to the Janus transducer
Pressure Case: Aluminum 500 m rated, or 6000 meter rated end cap with two connections: one wet-mateable connector with dummy plug for power and communications, one wet-mateable connection for the 5th beam transducer.
System Electronics: 1x set electronics mounted to Janus transducer, one set mounted to endcap, 1x flux-gate compass, 1x pitch and roll sensor, RS232 communications, 110-220VAC/24VDC power converter. 5 meter communications/power cable to allow data downloads from both sets of electronics.
Software: a comprehensive easy-to-use software package consisting of the following modules; (1) planning/consequences, (2) deployment/initialization, (3) data recovery, (4) memory erase, (5) data playback, (6) data listing, and (7) auto testing and field compass calibration.
Accessories: AC adapter, maintenance/tool kit, user's guide, operation manual, shipping crate.
Delivery: 120 days after receipt of order.

Table 1. Various measurable quantities for different transducer configurations, with assumptions and limitations.

	U, V, W		$-\overline{u'w'}$ and $-\overline{v'w'}$		$\overline{u'^2}, \overline{v'^2}, \overline{w'^2}$	
		Assumptions		Assumptions		Assumptions
3 Beam	Yes	No Redundancy	No	Insufficient Information	No	Insufficient Information
4 Beam Cyclops	Yes	With some Redundancy	Yes	Parital, only One.	$\overline{w'^2}$ only	Only Vertical
4 Beam Janus	Yes	With Redundancy	Yes	Homogeneous Turbulence	No	Insufficient Information
5 Beam Janus	Yes	With Redundancy	Yes	Homogeneous Turbulence	Yes	Isotropic Turbulence

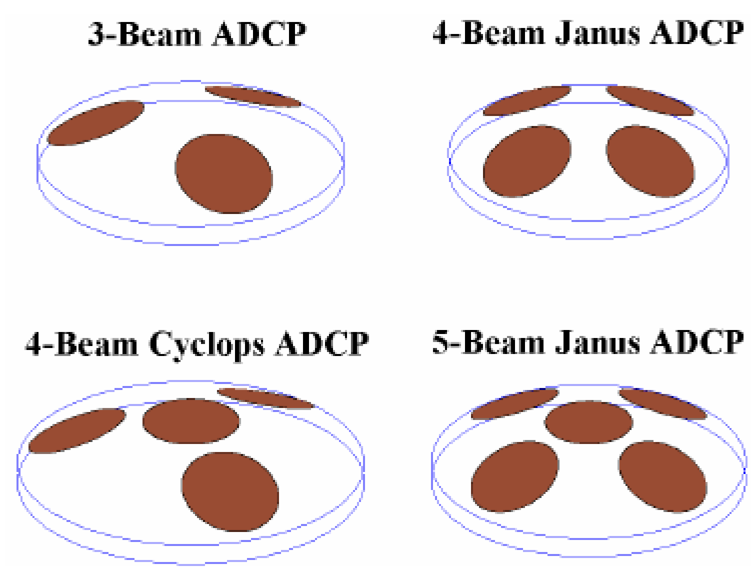

Figure 1. Various ADCP configurations: 3-beam (a), 4-beam Janus (b), 4-beam Cyclops (c), and 5-beam Janus (d), all in an upward pointing orientation.

IMAGE from Richard Dewey (2003).

Rough Estimate 600 kHz ADCP with Vertical 5 Beam Engineering and 6000m Depth Rating

Line #	Part #	Description	List Price	Qty	Total
1	WHS600 - 30 degree	WH Sentinel 600 kHz DR ADCP [1 (master)] 6000m rated Housing for Externally powered Direct Read Application.	$29,800.00	1	$29,800.00
2	WH5thbeam	WH 5th Beam Upgrade.	$26,800.00	1	$26,800.00
3	WHMEM1GIG	1 Gigabyte memory card (memory max 2 Gigs per Unit)	$419.00	4	$1,508.00
4	WHPRES-0100	Pressure sensor (100 m)	$800.00	1	$800.00
5		Sub Total			**~$58,908.00**

NOTES:

1: This system has RS232 communications only. If you require RS422 communications, the endcap and external battery case have to be modified with an 11 pin connectors with an additional cost of $1,900.00

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00053**
For:	Acoustic Current Meter (ACM)
Type:	Budgetary Quote / email
Date:	19 Sept 2008
Company:	Nobska, Inc.
Requested By:	SD

Notes: Also TRDI & Aquadopp viable

From: NOBSKA [nobska@compuserve.com]
Sent: Wednesday, September 17, 2008 11:39 AM
To: Skip Denny
Subject: Re: pricing?

Dear Skip

On 7/11/2008 I sent the following to you:

Here are prices on the assumption that you want Direct Reading only, NOT internal logging memory.

DEEP OCEAN MAVS 3000 Meters Depth:

1. MAVS-3DD with Hardcoat Anodized Aluminum Housing $8,300.00

2. MAVS-3DD with Titanium Housing $13,150.00

Both instruments are Direct Reading, RS-232 rated to 6,000 meters depth

3. Optional RS-485 interface for multiple MAVS on one node, cable length longer than 100 ft., , one Com Port
$750.00

SHALLOW MAVS for WAVES Measurements:

1. MAVS-3SD Direct Reading RS-232 2000 meters maximum depth $7,900.00

2. Optional RS-485 interface for multiple MAVS on one node, one Com Port
$750.00

3. Pressure Sensor Option for Waves 0.5% accuracy $980.00

4. Pressure Sensor Option for Waves 0.1% accuracy $1,840.00

5. MWAVES Software for calculation of Directional Wave Spectra $1,000.00

On purchase of 5 to 10 instruments, there is a 5% quantity discount. For more than 10, we can discuss additional discount.

I hope that this covers everything.

Best Regards
Dan Schaaf
K3ZXL www.k3zxl.com "In the Beginning, there was Spark Gap"
===============================
NOBSKA
www.nobska.net
===============================
Cape Cod Instruments
www.oceanbiz.net
===============================

----- Original Message -----
From: Skip Denny
To: NOBSKA@compuserve.com
Sent: Wednesday, September 17, 2008 1:56 PM

Subject: pricing?

Hi,

We (UW) are part of the NSF-OOI program with the cabled observatory segment (RSN, www.ooi.washington.edu) and as we head into Final Design Review we need to justify costs for the exemplar instruments on the system. As a cabled system, we provide power (up to 8 KVA) and bandwidth (up to 10 GigE) on a continuous basis via telecom cables spread over the Juan de Fuca plate off Oregon and Washington. Your MAV3 is one of those exemplar instruments, so would you please give me some costs for our budget? Also, what frequency does the instrument use (for interference reduction)?

Thanks,

Skip Denny

Senior Engineer

206 543-8042

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00054**
For:	Acoustic Modem
Type:	Budgetary Quote / email
Date:	19 Aug 2008
Company:	Teledyne-Benthos
Requested By:	SD

Notes: commercial item, see also WHOI micromodem

Quotation

TELEDYNE BENTHOS
A Teledyne Technologies Company

49 Edgerton Drive
North Falmouth, MA 02556-2826 USA
Phone: (508) 563-1000
Fax: (508) 563-6444
Website: www.teledynebenthos.com
E-mail: Benthos@Teledyne.com
Direct: CHiggins@Teledyne.com

Ship Via: Customer Specified
EXW: Factory, N. Falmouth,
Terms:
Quote is Valid until: 10/17/2008
Proposed Ship Date: 6 - 8 Weeks ARO
Date: 9/17/2008
Quote Number: 88727

Skip Denny
Applied Physics Lab - U. Washington
1013 40th St. NE
Seattle WA 98105-6698
Phone : 206 543-8042
denny@apl.washington.edu

Line Number	Part Number	Description	Qty	Price	Extend
1	013189	UDB-9000-M (LF) Low frequency Universal Deck Box (UDB) "M" Combined Modem and Acoustic Release Deck Box For operation with Benthos Acoustic Releases, Acoustic Modems and SMART Products. Internal rechargeable batteries. Touch screen. 2 Comm ports. Speaker. Splash proof case. 25m cable included. Transducer included.	1	$11,800.00	$11,800.00
				Sub-Total	$11,800.00

All standard Benthos terms & conditions of sale apply to this quote.

TELEDYNE BENTHOS
A Teledyne Technologies Company

Quotation

Date: 9/17/2008
Quote Number: 88727

Skip Denny
Applied Physics Lab - U. Washington
1013 40th St. NE
Seattle WA 98105-6698
Phone : 206 543-8042
denny@apl.washington.edu

Line Number	Part Number	Description	Qty	Price	Extend
2	013447	 ATM-887 4G DEEP MODEM WITH INTEGRAL LOW FREQUENCY OMNIDIRECTIONAL TRANSDUCER Includes alkaline batteries, I/O pigtail and manual. Low Freq. 9-14 kHz. Depth rated to 6000 meters.	5	$8,900.00	$44,500.00

Sub-Total $44,500.00

Total **$56,300.00**

Craig A. Higgins
Technical Sales
Acoustics & Communications
CHiggins@Teledyne.com

All standard Benthos terms & conditions of sale apply to this quote.

TELEDYNE BENTHOS
A Teledyne Technologies Company

Terms and Conditions of Sale (Revised August 1, 2008)

1. DEFINITIONS

"Seller" means Teledyne Benthos, Inc. "Buyer" means the legal entity purchasing Goods from Seller. "Goods" means the products offered by Seller and/or purchased by Buyer. "Offer" means any quote, proposal, or offer to sell Goods provided by Seller to Buyer. "Order" means any purchase order or similar instrument issued by Buyer to Seller to purchase Goods. Seller and Buyer are sometimes referred to herein individually as a "Party" and collectively as the "Parties".

2. ACCEPTANCE

The terms and conditions included in this "Terms and Conditions of Sale" document (hereinafter, this "Agreement") apply to all Offers made by Seller to Buyer and all Buyer's Orders accepted by Seller. Acceptance of Buyer's Order, and any changes or amendments thereto, is expressly conditioned upon Buyer's assent to these terms and conditions. Unless specifically agreed to in writing by a duly authorized representative of Seller, Seller objects to, and is not bound by, any terms or conditions that differ from or add to the terms and conditions specified herein. Seller's failure to object to any terms and conditions or any other provisions contained in any communication from Buyer, including, but not limited to, Buyer's Orders, does not waive any of the terms and conditions specified herein. Seller's acceptance of any resulting Order or Buyer's receipt of Goods, whichever occurs first, will conclusively evidence Buyer's unconditional acceptance of these terms and conditions. An Order minimum of $100.00 USD applies.

3. PRICES

Unless stated otherwise in writing by Seller, all prices are stated in U.S. Dollars and the prices offered are valid for a period of thirty (30) days from the date of Seller's Offer. The prices offered apply only to the specific quantities, specifications, and delivery schedules set forth in Seller's Offer. Any variation in quantity, specifications, or delivery schedules may necessitate a price and/or delivery schedule adjustment. Unless stated otherwise, all prices for domestic deliveries are F.O.B. Seller's place of shipment, as defined in the Uniform Commercial Code (UCC), and all prices for international deliveries are Ex-Works, as defined by INCOTERMS 2000.

4. CREDIT APPROVAL AND PAYMENT

Standard payment terms are net thirty (30) days from date of Seller's invoice, subject to credit approval of Buyer by Seller. Credit terms, shipments, and performance of work are at all times subject to the approval of Seller's Credit Department. Each shipment is a separate and independent transaction and payment must be made by Buyer accordingly.

If, prior to shipment of Buyer's Order, Buyer fails to fulfill the terms of payment of any prior invoice submitted by Seller, or if, in the opinion of Seller, Buyer's financial condition becomes impaired or unsatisfactory, Seller reserves the right to change, without notice, the terms of payment and/or delay or discontinue further shipments, without prejudice to any other available legal remedies, until past due obligations have been paid and Seller has received acceptable assurance regarding Buyer's prompt payment of future obligations. All amounts due to Seller but not paid by Buyer on the due date bear interest payable by Buyer to Seller in U.S. Dollars at a rate that is equal to the lesser of (i) one and one-half percent (1.5%) per month, or (ii) the maximum interest rate permitted under applicable law. Interest accrues on the balance of unpaid amounts as of the date on which portions of those amounts become due until the date payment is received by Seller. Buyer will also be liable to Seller for any expenses incidental to collection of past due amounts, including reasonable attorney's fees and court costs. In the event of Buyer's bankruptcy or insolvency, Seller is entitled to terminate any Order then outstanding and to receive reimbursement for termination costs and expenses as provided under Article 13, Termination for Default.

5. TAXES

The amount of any present or future sales, use, excise, import duty, or other tax applicable to the manufacture, sale, or lease of Goods will be added to the invoice and must be paid by Buyer, unless the Buyer provides Seller with a tax exemption certificate acceptable to the applicable taxing authority.

6. SHIPPING TERMS AND RISK OF LOSS

All domestic shipments by Seller are F.O.B. Seller's place of shipment, as defined in the Uniform Commercial Code. All international shipments by Seller are Ex-Works, as defined by INCOTERMS 2000. Risk of loss for Goods will transfer to Buyer upon Seller presenting Goods to carrier. If Seller prepays shipping, insurance, or other related costs, Buyer agrees to reimburse Seller promptly for the actual costs incurred by Seller plus ten percent (10%).

7. TOOLING

Unless otherwise provided by special written agreement signed by Seller and Buyer, all tooling, fixtures, equipment, tools, software, and designs produced, acquired, or used by Seller for the purposes of filling Buyer's Order remain the property of the Seller.

8. PACKING AND PACKAGING

Seller's prices for Goods include Seller's standard commercial packing and packaging. Any non-standard or special packing or packaging requirements requested by Buyer will be provided by Seller at additional cost to Buyer.

9. INSPECTION AND TESTS

All Goods manufactured by Seller are subject to Seller's standard inspection processes and, if applicable, acceptance testing at Seller's facility. Any additional requirements, including, without limitation, Buyer's source inspection or additional testing, are at Buyer's sole expense. If Seller and Buyer agree that Buyer is to inspect or provide for inspection at the place of manufacture, such inspection may not interfere unreasonably with Seller's operations and the Buyer's approval or rejection of Goods based on such source inspection and/or testing must be made prior to shipment of the Goods.

10. EXPORT COMPLIANCE; FOREIGN CORRUPT PRACTICES ACT

For any resale, export, or re-export of the Goods, Buyer must comply with all applicable export regulations, export licensing requirements, and the United States Foreign Corrupt Practices Act (FCPA), 15 U.S.C. §§ 78dd1 through 78dd3, as amended.

11. DELIVERY SCHEDULES AND FORCE MAJEURE

Shipping dates are approximate and require prompt receipt of all necessary Buyer-furnished information and material if applicable.

Seller is not liable for any damages, re-procurement costs, or penalties related to late deliveries. Without limiting the generality of the foregoing, Seller is not liable for delays due to force majeure, including, but not limited to, weather conditions, acts of God, acts of civil or military authorities, fires, strikes, job actions, floods, earthquakes, epidemics, quarantine restriction, war, terrorism, riot, supplier or vendor delays, or any other causes beyond the reasonable control of Seller. In the event of such delay, Seller will promptly notify Buyer and the date(s) of delivery will be deferred for a period commensurate with the time lost due to the delay. If the excusable delay under force majeure continues for more than ninety (90) days, Seller and Buyer will each have the option of terminating the affected Order(s) under Article 12, Termination for Convenience. If Seller's production is curtailed for any of the above reasons so that Seller is unable to deliver the full quantity of Goods scheduled for delivery to Buyer, Seller may allocate deliveries of available Goods among its various customers then under order for similar Goods. The allocation will be made in a commercially fair and reasonable manner. When such allocation has been made, Buyer will be notified of the estimated quota made available.

12. TERMINATION FOR CONVENIENCE

Buyer may request to terminate Buyer's Order for convenience in whole or in part and Seller agrees to cooperate with Buyer in attempting to make such arrangements conditioned on Buyer paying Seller for all deliveries made and for all work in process, including all applicable direct and indirect costs, settlements with suppliers, and related administrative, accounting, and legal costs, plus a normal profit. To the extent possible, Seller will use reasonable commercial efforts to divert materials and work in process from Buyer's Order to other customers' orders in order to minimize Buyer's termination costs.

13. TERMINATION FOR DEFAULT

Either Party may terminate the Order if the other Party breaches a material provision of this Agreement or of the Order. In the event that a Party (the "Defaulting Party") is in breach of a material provision of this Agreement or the Order, the other Party (the "Non-Defaulting Party") will submit a written cure notice to the Defaulting Party advising of such breach. The Defaulting Party will have five (5) days to cure the breach. If the Defaulting Party does not cure the breach within the five (5) day period, the Non-Defaulting Party may terminate the Order.

14. CHANGES ORDERS AND AMENDMENTS

All change order requests must be submitted by the Buyer to the Seller in writing and will not be effective unless and until Seller consents in writing to the change. Seller will advise Buyer in writing of the price and/or delivery schedule impact, if any, of the change request. Seller's acceptance of changes will be subject to Buyer's agreement to any price and/or delivery schedule adjustments.

15. LIMITED WARRANTY

Seller warrants that the Goods delivered under Buyer's Order will be free from defects in material and workmanship for a period of twelve (12) months from the date of original shipment, except for components and consumables that have shorter third party manufacturer's warranty periods. Components and consumables manufactured by third parties bear the warranty of their manufacturer.

The specific warranty for a given product is the one in effect on the date of shipment. In the event that Buyer identifies any defects in material or workmanship, Buyer will promptly notify Seller of the defective Goods and the specific nature of the defect in accordance with Article 16, Return Authorizations.

Seller, at its sole discretion, will either repair or replace any such Goods found by Seller to be defective. Seller's warranty does not apply to any Goods that have been subjected to improper installation, misuse, alteration, repair, neglect, accident, inundation, fire, or the like.

THESE EXPRESS WARRANTIES, INCLUDING REMEDIES, ARE EXCLUSIVE AND ARE IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS INTENDED OR GIVEN. IN THE CASE OF GOODS OTHER THAN THOSE OF SELLER'S OWN MANUFACTURE, SELLER MAKES NO WARRANTIES, EXPRESS, STATUTORY, OR IMPLIED.

16. RETURN AUTHORIZATIONS

Buyer will promptly notify Seller of any nonconformance(s) in the Goods and afford Seller a reasonable opportunity to inspect the Goods. No Goods may be returned without Seller's prior authorization, as evidenced by a return authorization. Once a return authorization number is obtained, Buyer will return defective Goods transportation and insurance prepaid in accordance with instructions issued by Seller. Failure to follow Seller's return procedures may result in lost Goods, delays, additional service, restocking charges, warranty denial, or refusal of a shipment. The return authorization number must appear on the shipping label along with all paperwork associated with the return. Seller has the right to reject Goods returned without the correct return authorization number clearly marked on the outside of the shipping container. Granting a return authorization number does not necessarily mean that a credit will be approved or that the evaluation or repair will take place without a fee.

17. INDEMNIFICATION

Each Party (the "Indemnifying Party") will hold harmless and indemnify the other Party (the "Indeminitee") against all claims, judgments, costs, and fees, including attorney fees, relating to infringement of U.S. patents, designs, copyrights, or trademarks to the extent that the infringing Goods are manufactured, sold, or used in whole or in part to the Indemnifying Party's specifications, designs, drawings, or other technical data.

To the extent that one Party's employees or agents enter on the property owned or controlled by the other Party, the first Party will indemnify and hold harmless the other Party, its officers, directors, and employees for any property damage or bodily injury or death caused by the first Party's employees or agents.

18. LIMITATION OF LIABILITY

NOTWITHSTANDING ANY OTHER PROVISIONS OF THIS AGREEMENT, UNDER NO CIRCUMSTANCES IS EITHER PARTY LIABLE FOR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL, INDIRECT, MULTIPLE, ADMINISTRATIVE, OR PUNITIVE DAMAGES, OR ANY DAMAGE OF AN INDIRECT OR CONSEQUENTIAL NATURE ARISING OUT OF OR RELATED TO ITS PERFORMANCE UNDER THIS AGREEMENT, WHETHER BASED UPON BREACH OF THIS AGREEMENT, WARRANTY, OR NEGLIGENCE AND WHETHER GROUNDED IN TORT, CONTRACT, CIVIL LAW, OR OTHER THEORIES OF LIABILITY, INCLUDING STRICT LIABILITY, EVEN IF ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SELLER'S TOTAL LIABILITY INCLUDING, BUT NOT LIMITED TO, LIABILITY FOR INDEMNITY, DEFENSE, AND HOLD HARMLESS OBLIGATIONS IS LIMITED TO NO MORE THAN THE AMOUNT PAID TO SELLER UNDER BUYER'S ORDER AND BUYER AGREES TO INDEMNIFY SELLER FOR ANY EXCESS AMOUNTS. TO THE EXTENT THAT THIS LIMITATION OF LIABILITY CONFLICTS WITH ANY OTHER PROVISION(S) OF THIS AGREEMENT, SUCH PROVISION(S) WILL BE REGARDED AS AMENDED TO WHATEVER EXTENT REQUIRED TO MAKE SUCH PROVISION(S) CONSISTENT WITH THIS PROVISION.

19. ARBITRATION AND LAW

Disputes that arise under this Agreement or Buyer's Order that cannot be settled amicably by the Parties will be settled by arbitration in Boston, Massachusetts in the United States of America under the prevailing rules of the commercial conciliation and arbitration rules of the American Arbitration Association. Judgment upon the arbitration award or decision may be entered in any court of competent jurisdiction. Arbitration awards and decisions are subject to Article 18, Limitation of Liability.

The laws of the State of Massachusetts, excluding its conflicts of laws provisions and excluding the United Nations Convention on the International Sale of Goods ("CISG"), govern the interpretation and enforcement of this Agreement and Buyer's Order.

20. ASSIGNMENT

Buyer may not assign or transfer this Agreement or any Order, in whole or in part, without the prior written approval of Seller.

21. ETHICS AND VALUES

Seller is committed to uncompromising ethical standards, strict adherence to law, and customer satisfaction. Buyer is encouraged to communicate any concerns or questions regarding the ethics and value to the Teledyne Corporate Ethics Help Line, "Take the Right Action", at 1-877-666-6968.

22. UNENFORCEABLE PROVISIONS

In the event that one or more provisions of this Agreement document is held to be unenforceable, the remaining provisions apply in full and the invalid or unenforceable provision will be replaced by a provision that lawfully enforces the Parties' intention underlying the invalid or unenforceable provision.

23. SURVIVAL

The following Article will survive the termination or expiration of this Agreement or any Order: 1: Definitions; 4: Credit Approval and Payment; 5: Taxes; 6: Shipping Terms and Risk of Loss; 7: Tooling; 9: Inspection and Tests; 10: Export Compliance; Foreign Corrupt Practices Act; 11: Delivery Schedules and Force Majeure; 12: Termination for Convenience; 13: Termination for Default; 15: Limited Warranty; 17: Indemnification; 18: Limitation of Liability; 19: Arbitration and Law; 20: Assignment; 22: Unenforceable Provisions; and 23: Survival.

24. WHOLE AGREEMENT; AMENDMENT

This document is the entire understanding between the Parties, and it supersedes all previous or additional agreements, arrangements, and drafts. This document may be amended or modified only by written agreement of duly authorized representatives of both Parties.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00055**
For:	Mass Spectrometer
Type:	Budgetary Quote / email
Date:	17 Oct 2008
Company:	PI & Monitor Instruments
Requested By:	SD

Notes: lean towards the TETHYS unit
.

Date: Wed, 17 Oct 2007 20:31:15 -0400
From: Peter Girguis <pgirguis@oeb.harvard.edu>
To: dskelley@u.washington.edu
Subject: Re: Mass Spec

HI DEB,

Did you get my last email about this?
Pete

PS If not, I'll write it up again. The short answer is "yes" we can do that. The instrument is the Stanford Research Systems RGA200 quadrupole mass spectrometer. I can send you quotes for all the off the shelf stuff.
Pete

> Hi Pete, if we put in $45,000 for the mass specs on the cable (at Hydrate Ridge) and possibly at Axial is that enough. Can you provide me with the name of the spectrometer used. I am getting ready for PDR and they want us to have e-mails from people if they are PI instruments (I'll remove your name) indicating the costs. I also have to get quotes from all the companys for off the shelf stuff...
>
> I finished my IGERT proposal yesterday, so can get back to the paper and other things I really want to get done this fall. I am in DC Wed-Fri for a UNOLS meeting. Do you got time to chat either this sunday, mon or tuesday..It would be good to catch up. I have not really even talked with you since the cruise.
> deb
>
> Dr. Deborah S. Kelley
> School of Oceanography
> Box 357940
> Seattle WA, 98195
> 206-543-9279
>
> Lab Group http://www.vents.washington.edu
> Lost City Expedition http://www.lostcity.washington.edu/
> Visions05 Expedition http://www.visions05.washington.edu/

~~~~~~

Peter Girguis, Ph.D.
Harvard University
Biological Labs
16 Divinity Ave
~~~~~~

Mass Spec 2-Tethys Preferred at this point

Hi Deb,

I'm flattered that you've asked for my input. I have written a few thoughts below with the outlook that science user requirements should not be overly restrictive. In some ways the TETHYS design parameters might be overkill, particularly if speed and resolution in the low mass range are not critical. Smaller/simpler systems may be able to gather the required data equally well at less cost/power. Therefore, I've tried to make suggestions with the goal of instruments generating useful data without bias for or against any particular design. Generally speaking, I think the endurance and long-term stability issues will be the most important criteria to establish.

It would be a great opportunity to put TETHYS instruments out on OOI moorings. I've talked with Monitor Instruments and they are willing to engage this as an at-cost demonstration. Our current estimate of the cost to have an instrument deployed for one year is $63k. Basically this amortizes the construction and maintenance cost over a year, assuming that at the end of a year's deployment the instrument would be brought back for a major overhaul.

Regarding isotopes, argon, carbon dioxide, and di-nitrogen will probably be the first gases that we demonstrate isotopic ratioing in-situ. I can send you some preliminary (unpublished) data if you like.

Anyway, I hope my suggestions help. Feel free to call or email me if you have questions or comments -some of the suggestions may be a little ambiguous.

Cheers,
Rich

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00056**
For:	Optical Attenuation
Type:	Budgetary Quote / email
Date:	24 Oct 2008
Company:	WETLabs, Inc.
Requested By:	SD

Notes: AC-9 is obsolete and being replaced by AC-9s – no price
On the new instrument, yet.

From: Julie Rodriguez [julie@wetlabs.com]
Sent: Friday, October 24, 2008 10:33 AM
To: 'Skip Denny'
Subject: RE: price updates

Attachments: WQM Price List Jan 2008 final.pdf; ECO Price List Jan 2008 final.pdf

Hello Skip,

I have attached our WQM and ECO product price lists for you. The price list for our ac meters is not finalized however the price of our ac9 is $17,500. As Angela is not here, I do not have access to the information she is preparing for you. Once she returns, I can have her send over what she has prepared for you.

If you have any questions, please do not hesitate to contact us. Let me know if I can be of further assistance in any way.

Best,

Julie Rodriguez

WET Labs, Inc.

-----Original Message-----
From: Skip Denny [mailto:denny@apl.washington.edu]
Sent: Thursday, October 23, 2008 3:51 PM
To: Julie@wetlabs.com
Subject: RE: price updates

No problem. I've lost track and just looked in my email box. Thanks,

Skip Denny

From: Julie Rodriguez [mailto:julie@wetlabs.com]
Sent: Thursday, October 23, 2008 3:47 PM
To: 'Skip Denny'
Subject: RE: price updates

Hi Skip,

I am sorry for the delay in getting pricing to you. I was under the impression that Angela was working with you on the pricing. Let me check what she has and I will get back to you, probably in the morning as she is out today. Sorry for any inconvenience this may have caused.

Best,

Julie Rodriguez

WET Labs, Inc.

-----Original Message-----
From: Skip Denny [mailto:denny@apl.washington.edu]
Sent: Thursday, October 23, 2008 3:31 PM
To: Julie@wetlabs.com
Subject: RE: price updates

Hi Julie,

I can’t seem to find any ROM quotes from you guys on the sensors. I hope I haven’t deleted it. Can you send it again? FDR is in 3 weeks with the costing the week prior.

Thanks,

Skip Denny

From: Julie Rodriguez [mailto:julie@wetlabs.com]
Sent: Tuesday, September 16, 2008 4:10 PM
To: 'Skip Denny'
Subject: RE: price updates

Hello Skip,
Thank you for inquiry. We will have updated prices for you in the next day or two, as we currently have part of our sales team out of the office.

Sorry for any inconvenience this may cause.

Best regards,

Julie Rodriguez

WET Labs, Inc.

-----Original Message-----
From: Skip Denny [mailto:denny@apl.washington.edu]
Sent: Tuesday, September 16, 2008 4:00 PM
To: sales@wetlabs.com
Subject: price updates

Hi,

As we near FDR for the NSF-OOI (www.ooi.washington.edu) project, we (UW) need to update our costs for sensors, et al, for basis of estimates. Can you give me some numbers for the following sensors?

AC-9 (quantity 6 for RSN)

ECO puck triplett (quantity 10 for RSN)

ECO BB2F (quantity 24 for RSN)

I realize its possible the Coastal/Global folks have already contacted you on this and if so, please just send me those numbers. We know this is a couple years off.

Many thanks,

Skip Denny

Senior Engineer

206 543-8042

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00057**
For:	RAS
Type:	Budgetary Quote / email
Date:	9 Oct 2008
Company:	PI
Requested By:	DSK

Notes:
.

OSMO Sampler
Date: Tue, 09 Oct 2007 06:32:13 -0700
From: Geoff Wheat <wheat@mbari.org>
To: dskelley@u.washington.edu
Subject: Re: Osmos on the Cabled Observatory

Howdy,
An OsmoSampler for a high temperature vent costs about $5,000 to machine and fabricate the pump portion and the intake portion. This is for one unit and would require a temperature probe (another $4,000 for a stand-alone system). In the case of an insert where there is a desire for two OsmoSamplers and the insert has the temperature probes, then the cost is about $9,000 to machine and fabricate. There is some economy in bulk purchases.

Take care,
Geoff

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00058**
For:	OTIS
Type:	Budgetary Quote / email
Date:	7 jULY 2008
Company:	PI
Requested By:	DSK

Notes: PI sensor, potentially unavailable. Another possibility:
"Mosquito" or a Raman Spectroscopy?

From: dskelley@u.washington.edu
Sent: Monday, July 07, 2008 11:44 AM
To: denny@apl.washington.edu
Cc: Mike Harrington
Subject: Hmm, where do we go from here?

Hmm, what to do with this type of information?? So it goes with programs that are delayed I guess. There is another model called a Mosquito, which I'll send a feeler out to--we are trying to hire the developer of this. It must be Monday. deb

deb

Dr. Deborah S. Kelley
School of Oceanography
Box 357940
Seattle WA, 98195
206-685-9556
206-543-9279

Lab Group http://www.vents.washington.edu Lost City Expedition http://www.lostcity.washington.edu/
Visions05 Expedition http://www.visions05.washington.edu/

---------- Forwarded message ----------
Date: Mon, 7 Jul 2008 11:31:21 -0700
From: Mike Tryon <mtryon@ucsd.edu>
To: Alison LaBonté <alabonte@nrcan.gc.ca>, dskelley@u.washington.edu
Subject: Re: Thanks for your help

Hi Deb and Ali

I don't have any current plans for bringing either the OTIS back to life or building a new electronic flow meter. The former would probably require some unpleasant interaction with Kevin which I prefer to avoid. The latter is something I've wanted to do and certainly could do but, at the moment, there are just too many other things consuming all of my time. I really need to clone myself. Anyway, if there was encouragement to proceed with development of a new instrument I could do it but it would push me to the point where I'll need to hire a full time development engineer because I just can' continue to wear both scientist and engineer hats (not to mention the home repairman and soon the Dad hat too!!!).

To try to put a number on the cost of such an instrument... I'd guess in the neighborhood of $100k for the first one and $50k for each additional one. There are a lot of unknowns in this estimate including interface to network beyond rs232, cost of titanium, ...

Two comments on the specs stated:

1) Flow rates of 1000 m/yr through sediment is not worth designing for in my opinion. In all the work we've done we've only seen it occur in one place, Monterey Bay. On the other end of the scale, having a lower resolution of 0.1 m/yr would mean losing the ability to measure changes in flow rate at seeps averaging <1 m/yr. This means you've designed an instrument that only works on maybe a couple percent of the seeps out there. So, in my opinion, an instrument with comparable resolution to the CATs is more useful if you want to look at

diffuse flow rates typical of cold seeps in sedimented areas. The Ridge environment is a whole other thing and there something more like what is described in the specs makes sense.

2) Temporal resolution is something you can't put a simple spec on. At high flow rates you have greater temporal resolution than at low rates. My rough estimate of the resolution is something like: (resolution in minutes) = 100*(flow rate in m/yr)^(-0.7)

Cheers,
Mike

ps - Ali - Have you figured anything out on the "familiarization training" thing?

Michael Tryon
Project Scientist
Scripps Institution of Oceanography, UCSD 9500 Gilman Dr., 0244 La Jolla, CA 92093-0244
office: 209 Vaughan Hall (858) 822-0591
lab: 100 Ritter Hall (858) 822-7742
Fax: (858) 822-3310
http://TryonLab.ucsd.edu

On Jul 7, 2008, at 10:11 AM, Alison LaBonté wrote:

> Hi Deb, Looks mostly correct to me. I have inserted some comments below.
> Mike, there are some questions for you at the end.
> Thanks
> Ali
>
>> On Jul 6, 2008, at 4:00 PM, dskelley@u.washington.edu wrote:
>>
>> Hi Ali, thanks much for giving me a call the other day and checking in.
>> Much appreciated and it was good to hear your voice-what a nice
>> surprise I keep thinking I'll make it up to Vancouver Island, but the
>> OOI project just continues to keep me buried. Still..it would be a
>> nice couple day trip!
>>
>> Thanks for offering to help me with the SUR's for a flow meter--here
>> is what I have. Any help, comments much appreciated.
>>
>> 1.3.7.6 Fluid Flow
>> The OOI shall measure flow into and out of sediments in at least one
>> methane seep site.
>>
>> The OOI shall measure flow into and out of sediments with resolution
>> of at least 0.1 to 1000 meters per year.
>>
>> The OOI shall measure flow into and out of sediments with a sample
>> rate at least every 5 minutes.
>>

>> The OOI shall measure flow into and out of sediments with max
>> temporal flow rate is 2 to 45 minutes.
> I'm actually not sure what this means since this "flow rate" of 2-45
> is in in a units of time, not distance/time..
>
>> The OOI shall measure flow into and out of sediments in units of
>> meters per year.
>>
>> The OOI shall measure temperature co-registered in space and time
>> with flow measurements.
> Currently, the instrument has temperature measurements only
> co-located. With slow to change temperature and flow rates, these two
> time series could easily be subsampled for adequate cross-correlation
> analyses. However, if there is a tectonic event, co-registered in
> time as well would be good. With more engineering (add a thermistor to the
system) this could be done.
>>
>> The OOI shall enable measurements of fluid migration to water depths
>> of at least 2000 m.
> the system was actually pressure tested up to full Alvin depth. what
> is that, 4500m?
> Please note that a little more testing is required on the system since
> the solenoid pump to inject the fluid had some trouble with vapor lock
> when pressurized during the Nootka buoy deployment (Hans Jannash has
> given good suggestions for dealing with this. the answers to this).
>>
>>
>> I "stole" these from your papers but am sure I missed something
>> and/or probably incorrectly stated something. Do you by any chance
>> have an updated cost on what it would take to put one of these on the
cable????
>> thanks again..hope you had a good weekend, deb
>>
>
> Hmm, errr... I am not sure how to calculate what the cost of having a
> full time grad student on the project for a year is..
> the system itself was something like $15,000 in parts and fabrication.
> Any words here Mike? Actually, Mike, weren't you thinking of building
> something completely different, an electronic CAT meter of sorts? I
> don't know what is happening with that these days, or what the cost of that
would be.
>
> Cheers,
> Ali
>
>> Dr. Deborah S. Kelley
>> School of Oceanography
>> Box 357940
>> Seattle WA, 98195
>> 206-685-9556
>> 206-543-9279
>>
>> Lab Group http://www.vents.washington.edu Lost City Expedition
>> http://www.lostcity.washington.edu/
>> Visions05 Expedition http://www.visions05.washington.edu/
>
>

>
>
>

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00059**
For:	T_H2_H2S_pH
Type:	Budgetary Quote / email
Date:	6 Oct 2008
Company:	PI
Requested By:	DSK

Notes: $15K
.

Temperature-H2-pH-H2S
Date: 06 Oct 2007 15:46:38 -0500
From: wes@umn.edu
To: dskelley@u.washington.edu
Subject: Re: pH-H2S-T sensor

Hi Deb,

That number is still realistic- sounds like you are really busy- I dont think I
will make cocktails at the Parc this year- cruise in December

Bill
On Oct 6 2007, dskelley@u.washington.edu wrote:

> Hi Bill, I am getting ready for the Project Design Review in December for the
> cabled observatory. As part of this, I have been asked to confirm numbers used
> in our costbook. When I last e-mailed you, you indicated that your sensor was
> ~ $15K..is this still a realistic number? In the current thoughts, we would
> cover connectors, and CI may cover costs for changing logging protocols. I
> will take your name off the e-mail, but wanted to confirm with you that this
> is an ok ballpark #.
>
> Hope you are well..it has been really crazy here with trying to get ready for
> the review, complete requirements, and I just submitted a big IGERT proposal
> yesterday..now am digging out.
>
> Will I see your smiling face at AGU--I have a room booked at Parc 55 :)
>
> deb
>

> Dr. Deborah S. Kelley
> School of Oceanography
> Box 357940
> Seattle WA, 98195
> 206-543-9279
>
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Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00060**
For:	T_H2_H2S_pH
Type:	Budgetary Quote / pers. comm.
Date:	22 Aug 2008
Company:	PI: Rex Johnson
Requested By:	DSK

Notes: Rex retired, APL can/will build, est. $30K

From: Jim Beck [jim@sunburstsensors.com]
Sent: Monday, September 22, 2008 1:33 PM
To: Skip Denny
Subject: Re: quote

I'm not sure if I talked to anyone w/ you guys or not. There is a 1500 m version of the SAMI-pH. Instruments are currently priced at $17K for the 100 m version and $19K for 1500 m version. Mooring cages are $1400 if you need them. If you want this in formal quote let me know.

regards,
Jim

Jim Beck
jim@sunburstsensors.com

On Sep 16, 2008, at 12:47 PM, Skip Denny wrote:

I’m working on the RSN (cable observatory) segment of the OOI. We’re facing a Final Design Review in November and need costs for our basis of estimates. Hopefully I’m not duplicating the Coastal/Global’s efforts. If so, could you just send me a copy of their quote?

Can I get an update quote for a SAMI-1500 pCO2 sensor? Also for pH. Will you be making a pH sensor that will go to 200m?

Many thanks,

Skip Denny
Senior Engineer
206 543-8042

<Gerald (Skip) Denny (Denny@apl.washington.edu).vcf>

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00061**
For:	Temp_Resist
Type:	Budgetary Quote / email
Date:	6 Oct 2008
Company:	PI
Requested By:	DSK

Notes: $45K
.

Temperature-Resistivity
>Date: Sat, 6 Oct 2007 13:51:17 -0700
From: Marvin Lilley <lilley@u.washington.edu>
To: dskelley@u.washington.edu
Subject: Re: T-R

Hi Deb, I assume you mean $45K/sensor. This is probably ok but if this is going to set anything in stone, I should get updated numbers.
Marv
----- Original Message ----- From: <dskelley@u.washington.edu>
To: <lilley@u.washington.edu>
Sent: Saturday, October 06, 2007 1:18 PM
Subject: T-R-Â±H2

> Hi Marv, I have been told to get emails from researchers regarding sensors we
> now have listed as "core" sensors on the cable (how this will actually be done
> is unknown--i.e. there may be a general rfp put out for each sensor type).
> Anyway, for PDR I have been asked to get e-mails from the PI's (will remove
> names). As a working # i have $45/sensor for you -- is this reasonable (not
> counting connectors, and cost of getting the data logging protocol done--CI is
> supposed to do that).
>
> Hope you are having a good weekend--I am digging out after the IGERT. deb
>
> Dr. Deborah S. Kelley
> School of Oceanography
> Box 357940
> Seattle WA, 98195
> 206-543-9279
>
> Lab Group http://www.vents.washington.edu
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> Visions05 Expedition http://www.visions05.washington.edu/
>

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66390**
For:	Metrohm Dosimat Automatic Titrator
Type:	Budgetary Quote /Email / Notes
Date:	8/12/2010
Company:	Metrohm USA
Requested By:	GP

Notes:
For Alkalinity titrations and O2 titrations

Metrohm-USA
6555 Pelican Creek Circle
Riverview, FL 33578
USA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

Quotation No. / Date
QT2009815 / 08/12/2010

3 year
instrument warranty

Comment:

Terms & Conditions:

New customers subject to credit approval. All prices
responsibility of the customer and will be calculated
order. Metrohm-USA accepts payment by check, El
invoice unless otherwise noted.

Arthur Millrod 415-286-3665
Oxygen titrators
Metrohm U.S.A
amilrod@metrohmusa.com

75000 (1)
888 (2)
titrando 13,000 (3)
905

new burette

0.5 ml/rec
2,5,10,20 ~2ml increment
burret size

Burett drive on top of burrette
- no bubbles
- can completely empty burrette completely
- electronics above the liquid
- less space
- can control more than 1 drive
could use one to deliver std?

12K 1 drive, 1 burrett & stirrer
Second burret & drive 3K

Endpoint potentiometric (Pt electrode) basic
Can use (colorimeter)

Probe extra cost of colorimeter 3K

nobody in Seattle

884

titrator 5ml burrette

tbase full data ackuisition

905

have to have { Titrator 11.2

software 2.8

Colormeh 3.0

Pt 0.5

second burette 2.7

→ 1.1

19.2

requires computer too

884

Titrator + burette 7.0

Pt 0.5

Colorimeter 3.0

Color filters .2

10.7

Metrohm-USA
6555 Pelican Creek Circle
Riverview, FL 33578
USA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

Metrohm USA Inc.
Formerly Brinkmann Instruments in the U.S.

Quote Issued for:

University of Washington
School of Oceanography, Box 357940
Seattle, WA, 98195-7940
US

Attn: Steven Emerson
Phone: (206) 543-0428
Email: emerson@u.washington.edu

Quotation

Quotation No. / Date
QT2009817 / 08/12/2010

Reference No.: QT-6365/2

Valid From
08/12/2010 / 09/30/2010

Please reference this Quotation when ordering.

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Sincerely,

Arthur Milrod
Sales Representative
amilrod@metrohmusa.com
800-727-6768 Ext.2442

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Catalog No.	Catalog Description	Quantity	List Price	Unit Price	Amount
System					
020888109	848 TITRINO PLUS 5mL w/ 801	1	7,500.00		7,500.00
			7.00%		-525.00
			6,975.00		6,975.00
020924357	COMB PT RING EL-LL 6.0451.100	1	520.00		520.00
			7.00%		-36.40
			483.60		483.60
	COMB PT RING EL-LL 6.0451.100				
020238259K	PROBE COLORIMETER PC950	1	3,200.00		3,200.00
			7.00%		-224.00
			2,976.00		2,976.00
020231041	FILTER,450NM W/HOLDER	1	250.00		250.00
			7.00%		-17.50
			232.50		232.50
	Filter, 450nm, for PC 700,800,900				
020237317	CABLE PC9X0-F PLUG 1M	1	73.00		73.00
			7.00%		-5.11
			67.89		67.89
	Cable (1 meter) to connect PC910 to a Titrino with "F" type input plug				
System subtotal amount (USD)					**10,734.99**

Catalog No.	Catalog Description	Quantity	List Price	Unit Price	Amount
Recommended Accessories					
020018961	USB THERMAL PRINTER 2.141.0100	1	800.00		800.00
			7.00%		-56.00
			744.00		744.00
020993393	tiBase Full	1	1,800.00		1,800.00
			7.00%		-126.00

hm-USA
Pelican Creek Circle
erview, FL 33578
SA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

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Catalog No.	Catalog Description	Quantity	List Price	Unit Price	Amount
			1,674.00		1,674.00

Recommended Accessories subtotal amount (USD)	**2,418.00**

Metrohm-USA
6555 Pelican Creek Circle
Riverview, FL 33578
USA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

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3 year
instrument warranty

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Comment:

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etrohm-USA
555 Pelican Creek Circle
Riverview, FL 33578
USA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

Metrohm USA Inc.
Formerly Brinkmann Instruments in the U.S.

Quote Issued for:

University of Washington
School of Oceanography, Box 357940
Seattle, WA, 98195-7940
US

Attn: Steven Emerson
Phone: (206) 543-0428
Email: emerson@u.washington.edu

Quotation

Quotation No. / Date
QT2009815 / 08/12/2010

Reference No.: QT-6365/1

Valid From
08/12/2010 / 09/30/2010

Please reference this Quotation when ordering.

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If you have any questions or would like to amend this document, please feel free to contact us.

Sincerely,

Arthur Milrod
Sales Representative
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Riverview, FL 33578
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E-mail: custserv@metrohmusa.com

Metrohm USA Inc.
Formerly Brinkmann Instruments in the U.S.

Quotation No. / Date
QT2009815 / 08/12/2010

Catalog No.	Catalog Description	Quantity	List Price	Unit Price	Amount
System					
020771322	905PC1 / 5ML / 801	1	12,000.00		12,000.00
			7.00%		-840.00
			11,160.00		11,160.00
	905 Titrando with 1-input, PC Control Cable 800 Dosino, 5 mL 807 Intelligent Dosing Unit and 801 Stirrer				
020993210	TIAMO 2 LIGHT CD: 1 LICENSE	1	2,500.00		2,500.00
			7.00%		-175.00
			2,325.00		2,325.00
	tiamo™ 2 Light - one license for control of up to 2 systems. System Requirements: Operating system: Windows 2000 SP4, Windows XP Professional SP2, Windows Vista 32-bit ONLY, Windows 7 32-bit ONLY" RAM: 2GB (Windows Vista / W7) Memory Program: 500MB Data: 2 GB (for about 5000 determinations Serial ports for devices with RS232 interface USB ports for devices with USB interface. The windows user must have administrator rights in order to be able to install the tiamo™ software.				
020924357	COMB PT RING EL-LL 6.0451.100	1	520.00		520.00
			7.00%		-36.40
			483.60		483.60
	COMB PT RING EL-LL 6.0451.100				
020238259K	PROBE COLORIMETER PC950	1	3,200.00		3,200.00
			7.00%		-224.00
			2,976.00		2,976.00
020231041	FILTER,450NM W/HOLDER	1	250.00		250.00
			7.00%		-17.50
			232.50		232.50
	Filter, 450nm, for PC 700,800,900				
020237317	CABLE PC9X0-F PLUG 1M	1	73.00		73.00
			7.00%		-5.11
			67.89		67.89
	Cable (1 meter) to connect PC910 to a Titrino with "F" type input plug				

ohm-USA
5 Pelican Creek Circle
verview, FL 33578
JSA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

Metrohm USA Inc.
Formerly Brinkmann Instruments in the U.S.

Quotation No. / Date
QT2009815 / 08/12/2010

Catalog No.	Catalog Description	Quantity	List Price	Unit Price	Amount
System subtotal amount (USD)					**17,244.99**
Recommended Accessories					
020763108	DOSINO 800/5 COMPLT	1	2,880.00		2,880.00
			7.00%		-201.60
			2,678.40		2,678.40
	Model 800 Dosino dosing device with 10,000 pulse resolution, complete with 5 ml buret and 1L amber glass bottle.				
020879580	ADD ON INPUT SET FOR 90X TITRANDO	1	1,200.00		1,200.00
			7.00%		-84.00
			1,116.00		1,116.00
Recommended Accessories subtotal amount (USD)					**3,794.40**

Metrohm-USA
6555 Pelican Creek Circle
Riverview, FL 33578
USA
Phone: (800) 727-6768
Fax: (813) 316-4900
E-mail: custserv@metrohmusa.com

Metrohm
USA Inc.
Formerly Brinkmann Instruments in the U.S.

Quotation No. / Date
QT2009815 / 08/12/2010

3 year
instrument warranty

Metrohm-USA in partnership with Metrohm offers a 3-year warranty for all new Metrohm Instruments. For complete details, please see our warranty statement.

Comment:

Terms & Conditions:

New customers subject to credit approval. All prices quoted in US Dollars and are valid for thirty (30) days, unless otherwise noted. Taxes are the responsibility of the customer and will be calculated and applied at the time of invoicing. Proof of tax-exemption, if applicable, must be presented at time of order. Metrohm-USA accepts payment by check, EFT or by American Express, VISA and Mastercard. Payment is due net 30 days upon transmission of invoice unless otherwise noted.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66391**
For:	Gas Chromatograph
Type:	Web
Date:	3/29/2011
Company:	SRI
Requested By:	GP

Notes:
For shipboard analysis of volatiles
Quotes from SRI and Quadrex for GC only. Valving and inlet systems are a custom build.

QUADREX CORPORATION

P.O. Box 3881

Woodbridge, CT 06525 U.S.A.

Tel............................203.393.3112

Toll-Free.................. 800.275.7033

Fax.......................... 203.393.0391

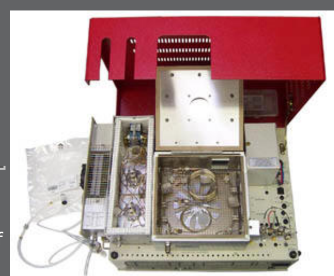
E-Mail..........sales@quadrexcorp.com

SRI PRECONFIGURED GC SYSTEMS - TRANSFORMER OIL GAS ANALYZER (TOGA) GC

SRI PRECONFIGURED GCs
SRI ACCESSORIES
SRI DETECTORS
SRI INJECTORS
SRI GC MAINFRAMES

SRI TOGA GC

- **HID, FID and/or TCD detectors**
- **10-port gas sampling valve and valve oven**
- **Gas extraction loop**
- **Peaksimple data system**
- **Built-in standards preparation module**



By analyzing the gases dissolved in transformer oil, potential transformer faults can be avoided. ASTM D3612 provides for identification and quantification of dissolved gases in transformer oil by GC. The SRI TOGA GC uses the version referred to as D3612B, the direct injection technique where the dissolved gas extraction takes place inside the GC. This means that other than collecting the transformer oil in a glass airtight syringe, no sample preparation is necessary prior to injection into the TOGA GC.

The presence and quantities of certain gases in the transformer oil indicate four broad types of possible general fault conditions:

1-*Transformer oil overheating:* methane, ethane, ethylene, and small quantities of acetylene
2-*Partial Discharge:* hydrogen, methane, and small quantities of acetylene and ethane
3-*Sustained Arcing:* hydrogen, acetylene, and ethylene
4-*Insulating Paper Overheating:* carbon monoxide and carbon dioxide

To achieve the TOGA analysis, transformer oil is pumped through the gas extraction loop of a TOGA GC equipped with HID or HID/TCD detectors. The TCD is used to quantify the oxygen and nitrogen because the HID is too sensitive for the large quantities typically found dissolved in transformer oil.

In the TOGA GC, the transformer oil sample is injected by peristaltic pump through a unique gas extraction loop. The gas extraction loop consists of permeation membrane tubing encapsulated in a trap-heated glass tube. The permeation tubing is plumbed to the sample inlet, the dual 10-port valves, and the waste/sample outlet. Solenoid valves are included for purging the gas extraction chamber with helium between runs.

#SRI-8610-0031-1, TOGA GC WITH HID (110V)	$17,495.00
#SRI-8610-0031-2, TOGA GC WITH HID (220V)	$17,495.00
#SRI-8610-0032-1, TOGA GC WITH TCD/HID (110V)	$20,495.00
#SRI-8610-0032-2, TOGA GC WITH TCD/HID (220V)	$20,495.00

Options & Upgrades: *additional detectors, 6 channel USB PeakSimple data system*

Hot Tip

PRECONFIGURED GCs TAKE ADVANTAGE OF BATCH MANUFACTURING, OFFERING A LOT OF GC POWER AT VERY REASONABLE PRICING.

Next Page | Previous Page | Preconfigured GC Overview | SRI Product Index | HOME

8610-0270

- ***Separates a wide variety of peaks in a single injection, including water***
- ***Tolerant of user adjustments and timing variations***
- ***Simpler than other multiple gas capable systems***

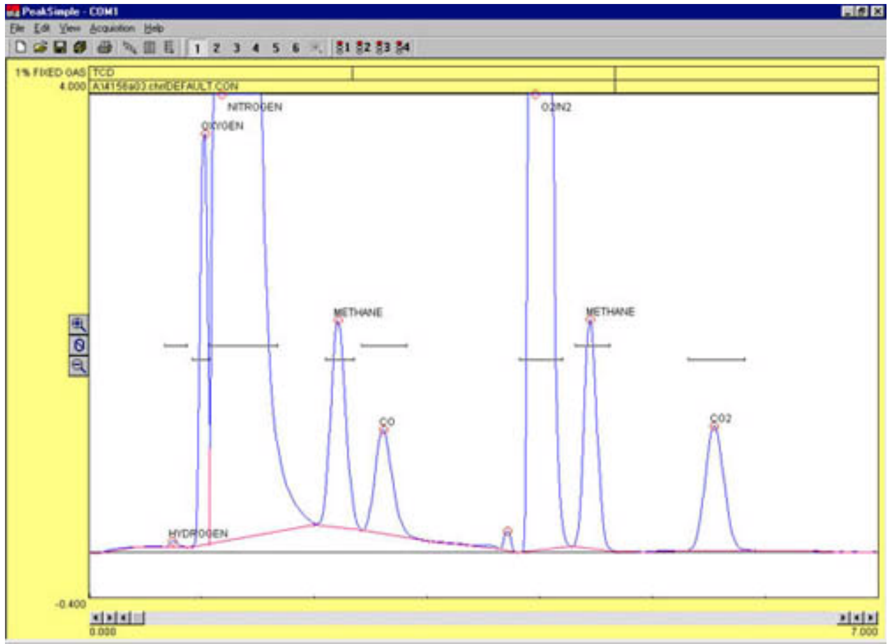
The basic MG#2 model includes:

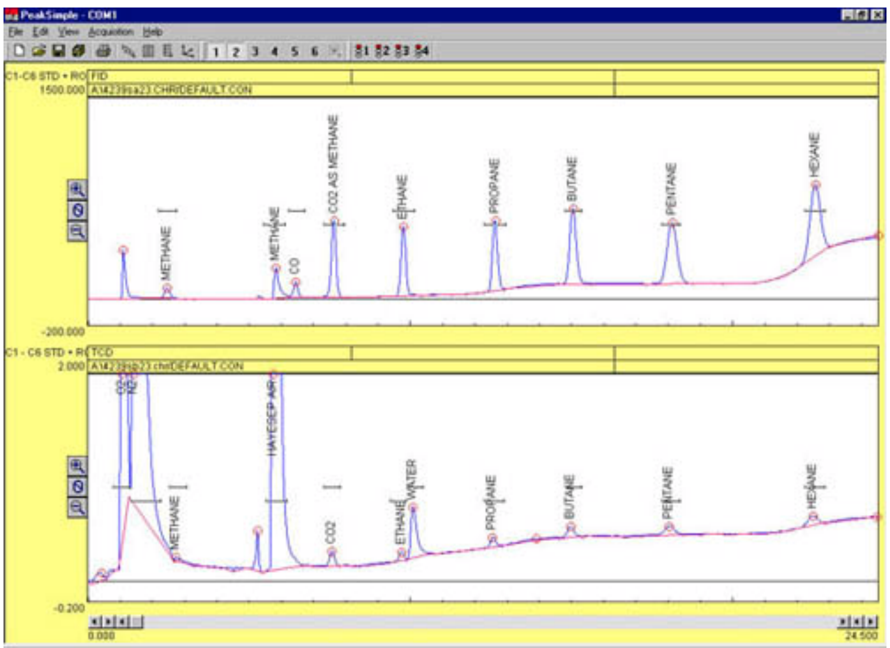
- **TCD detector**
- **molecular sieve 13X & HayeSep D packed columns**
- **10-port gas sampling valve and dual loops**
- **1 channel PeakSimple data system ...on the compact 8610C chassis**

The Multiple Gas Analyzer #2 GC system (MG#2) is pre-plumbed and ready to resolve H_2, O_2, N_2, methane, CO, ethane, CO_2, ethylene, water, alcohols, propane, butanes, pentanes and C_6. The MG#2 is similar to the MG#1, except that the MG#2 can measure water and alcohol in addition to the multiple gas compounds. This configuration has since been superseded by the MG#3 series GCs, offering improved performance at a lower price.

To separate such a wide variety of peaks without co-elution, the MG#2 turns on the carrier gas flow to each column at different times during the run. This allows the Molecular Sieve column to complete the separation of H_2, O_2, N_2, CH_4 and CO, at which point the molecular sieve carrier flow is turned off and the HayeSep-D carrier flow is turned on. The HayeSep D column then separates all compounds in the C_1-C_6 range. An ***optional*** capillary column in parallel with the HayeSep-D can also be useful in separating the hydrocarbons out through C_{20}. Detectors can be TCD, HID, FID, or any combination, depending on your application needs.

This chromatogram shows the separation of a 1% Gas Standard sample on a MG#2 equipped with a TCD detector. The first five peaks came off the molecular sieve column, and the following three peaks came off the HayeSep D column. Note that the methane elutes twice, once from each column.





These two chromatograms show the separation of a 1000 ppm C_1-C_6 standard plus room air on a MG#2 GC equipped with TCD (bottom chromatogram) and FID (top chromatogram) detectors.

8610-0271 ***customized*** for a particular customer with an HID detector and a 30 meter capillary column

- This modified MG#2 (8610-0271) is equipped with:

- **TCD detector**
- **optional HID detector**
- **FID-methanizer**
- **optional 30 meter capillary column**
- **molecular sieve 13X & HayeSep D packed columns**
- **10-port gas sampling valve and dual loops**
- **6 channel PeakSimple data system**

- customize a system of your own!

8610-0270	**Multiple Gas Analyzer #2 with TCD detector and 1 channel PeakSimple data system**	**$11,839.00**
8610-0271	**Multiple Gas Analyzer #2 with TCD, Methanizer, FID, built-in "whisper quiet" air compressor, and 6 channel PeakSimple data system**	**$15,959.00**
8610-0272	**Multiple Gas Analyzer #2 with TCD and HID detectors, and 6 channel PeakSimple data system**	**$16,479.00**
8610-0273	**Multiple Gas Analyzer #2 with TCD, Methanizer, FID, FID/FPD, 60 meter capillary column, built-in "whisper quiet" air compressor, and 6 channel PeakSimple data system**	**$22,659.00**
(VOLTAGE: for 220VAC, order "8610-0270-2" (add "-2" to part number)		
Options & Upgrades: additional gas sampling valve, additional detectors, additional columns		

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66392**
For:	Benchtop pH meter
Type:	Web
Date:	3/29/2011
Company:	Fischer Scientific
Requested By:	GP

Notes:
Accumet pH benchtop system for shipboard analysis of vent fluid pH

Search

accumet

Submit MSDS Search
Substructure Search
Certificate Of Analysis

Custom Oligos »

Shopping Cart View Cart
No items in cart

For security reasons you will be automatically logged out after 30 minutes of inactivity.

Back to Search Results

Fisher Scientific* accumet* Excel XL25 pH/mV/Temperature/ISE Meter

XL25 pH.mV/ISE/Temperature Meter

Ion selective electrode measurement has never been this easy

Unrivaled usability and connectivity

- Windows CE*-driven, full-color touchscreen provides unmatched ease of use in operation and setup
- Switchable numeric display with complete measurement data or graphic display mode for at-a-glance view of measured data over time
- User prompts and context-specific HELP screens easily guide user through operation
- Extensive setup screens allow you to customize the meter precisely to your needs

Dual channel measurement and display for fast and flexible research-grade analyses

- Automatic temperature correction: ATC probe in each channel
- ISE mode offers direct and indirect measurements
- pH mode accepts standard or accuFet* nonglass electrodes
- Provides two pH/mV/ISE inputs, two ATC inputs, plus an input for the accuFet nonglass electrode
- Advanced circuitry and shielding prevent crosstalk and other interference
- Password security to protect data from deletion

See details

Includes:

- **Meter Kit/pH** package includes meter, accuCap* combination pH electrode (13-620-130), ATC probe (13-620-19), electrode support arm and bracket, 110/220V power supplies and operation manual.
- **Meter Only** package includes meter, electrode support arm and bracket, 110/220V power supply and operation manual.

Each package above is also available with Certificate of Traceability to NIST* Standards.

Meter/Software Kit package includes meter, accuCap* combination pH electrode (13-620-130), ATC probe (13-620-19), electrode support arm and bracket, 110/220V power supplies and operation manual, plus powerful, comprehensive data management software. Designed in compliance with FDA's 21 CFR Part 11 regulations, this software lets you expand the memory space of your meter to your personal computer's hard disk, and manage multiple projects under separate ID logins. Password security protects each ID login's data from tampering and accidental deletion.

Items | Details | Images

Description	Catalog Number	Quantity	Price
Meter without electrode View Accessories	13-636-XL25A		Each for $2,026.00 Add to Cart
Meter w/o electrode; NIST certified	13-636-XL25AC		Each for $2,376.39 Add to Cart
Meter w/Electrode View Accessories	13-636-XL25		Each for $2,321.00 Add to Cart
Meter kit w/accuCap combination pH electrode	13-636-XL25C		Each for $2,683.75 Add to Cart
Meter kit w/21 CFR software	13-636-XL25S		Each for $2,380.62 Add to Cart

Add Items to Cart

Back to Search Results

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66393**
For:	UV-Vis Spectrophotometer
Type:	Budgetary Quote
Date:	4/12/2011
Company:	Agilent
Requested By:	GP

Notes:
UV-Vis Spectrophotometer with 10cm path length cell for shipboard analysis of water column pH

Agilent Technologies

Quotation

Giora Proskurowski
University of Washington
1705 NE Pacific St
Seattle WA 98195-0001

Quote No.	Create Date	Delivery Time	Page
1064566	04/12/2011	5 Weeks	1 of 4

Contact	Phone no.	Valid to
Charley Hernandez	302-633-7447	07/11/2011

To place an order: Call 1-800-227-9770 Option 1
For Instruments Fax : 302-633-8953
For Consumables Fax : 302-633-8901
Email : LSCAinstrumentsales@agilent.com
For additional instructions, see last page

Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
G1103A 8453 UV-visible Spectrophotometer. Includes single-beam, deuterium and tungsten lamps, 1024-element diode-array, 190-1100 nm, 1 nm optical slit width and GPIB, LAN and GP-IO interfaces. With the following configuration: Ship-to Country : USA Installation (44K)	1.000 EA	**11,898.00 USD**	**2,379.60-**	**9,518.40**
Purchase Agreement discount of 20.00 % is applied G6I77				
5061-3392 Cell, Quartz cyl 100mm pathlength	1.000 EA	**237.00 USD**	**35.55-**	**201.45**
Purchase Agreement discount of 15.00 % is applied G6I77				
89076C Long path-length cell holder. For cylindrical and rectangular cells with up to 10 cm path-length. Includes stops at 1, 2 and 5 cm.	1.000 EA	**389.00 USD**	**77.80-**	**311.20**
Purchase Agreement discount of 20.00 % is applied G6I77				

Agilent Technologies

Quotation

Quote No.	Create Date	Delivery Time	Page
1064566	04/12/2011	5 Weeks	2 of 4

Contact	Phone no.	Valid to
Charley Hernandez	302-633-7447	07/11/2011

Giora Proskurowski
University of Washington
1705 NE Pacific St
Seattle WA 98195-0001

To place an order: Call 1-800-227-9770 Option 1
For Instruments Fax : 302-633-8953
For Consumables Fax : 302-633-8901
Email : LSCAinstrumentsales@agilent.com
For additional instructions, see last page

Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
G1115AA	1.000 EA	**3,521.00 USD**	**704.20-**	**2,816.80**

UV-visible General Purpose software.
Includes easy-to-use, graphical user interface, standard and verification and diagnostics modes. Controls 8453 spectrophotometer.

With the following configuration:
Ship-to Country : USA

Installation (44K)
1 Year SW Update/Phone Assist (44W)

Purchase Agreement discount of 20.00 % is applied G6I77

Gross Amount	: $	16,045.00
Total Discount	: $	3,197.15
Net Amount	: $	12,847.85
Sales Tax	: $	1,220.53
Total	**: $**	**14,068.38**

Quotation

Agilent Technologies

Quote No.	Create Date	Delivery Time	Page
1064566	04/12/2011	5 Weeks	3 of 4

Contact	Phone no.	Valid to
Charley Hernandez	302-633-7447	07/11/2011

Giora Proskurowski
University of Washington
1705 NE Pacific St
Seattle WA 98195-0001

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For Instruments Fax : 302-633-8953
For Consumables Fax : 302-633-8901
Email : LSCAinstrumentsales@agilent.com
For additional instructions, see last page

TO PLACE AN ORDER, Agilent offers several options:

1) Visit **http://www.agilent.com/chem/supplies** to place online orders using a purchase order or credit card.
2) Call 1-800-227-9770 (option 1) any weekday between 8am and 8 pm Eastern time in the U.S., Canada & Puerto Rico.
3) To place an order for Consumables, please fax the order to 302-633-8901.
   To place an instrument and/or software order, please fax the order to 302-633-8953.
4) Or you can mail your order to:
   Agilent Technologies
   North American Customer Contact Center
   2850 Centerville Road BU3-2
   Wilmington, DE 19808-1610

To place an order, the following information is required:

- Purchase order number or credit card, delivery date, ship to, invoice to, end user, and quote number.
- GSA customers please provide GSA contract #.

EXCLUSIVE OFFERS FOR NEW INSTRUMENT CUSTOMERS, go to **www.agilent.com/chem/exclusiveoffers**

TO CHECK THE STATUS OF AN ORDER:

1) Visit **http://www.agilent.com/chem/supplies** to check the status of your order.
2) Call 1-800-227-9770 (option 1) any weekday between 8 am and 8 pm Eastern time, in the U.S., Canada & Puerto Rico. You will need to know the purchase order or credit card number the order was placed on.

FINANCING AND LEASING - A wide range of options are available from Agilent's preferred financing partner, Leasing Group Inc. (LGI).

For more information or to discuss how monthly payments could suit your operational or budgetary requirements, contact your Agilent Account Manager or contact LGI at 800-944-1370.

TERMS AND CONDITIONS:

This offer is subject to Agilent Technologies' Standard Terms and Conditions of G6I77.

- Pricing: Web prices are provided only for the U.S. in U.S.dollars. All phone prices are in local currency and for end use. Applicable local taxes are applied.
- All Sales Tax is subject to change at the time of order.
- Shipping and Handling Charges: Orders with a value less than $2000 or those requiring special services such as overnight delivery may be subject to additional shipping & handling fees. Some of these charges may be avoided by ordering via the Web
- Payment Terms: Net 30 days from invoice date, subject to credit approval.

* Quotation Validity: This quotation is valid for 90 days unless otherwise indicated.
* Warranty period for instrumentation is 1 year. The Warranty period for columns and consumables is 90 days.

Visit **www.agilent.com/chem**

- For Training course information and registration including e-Seminars, select Education.
- For Literature, Application notes, and other information, select Library.
- For Online Technical Support including the Technical Support Assistant and Frequently Asked Questions, select Technical Support.

It is Agilent Technologies intent to ship product at the earliest available date unless specified otherwise.

Agilent Technologies

Quotation

Quote No.	Create Date	Delivery Time	Page
1064566	04/12/2011	5 Weeks	4 of 4

Giora Proskurowski
University of Washington
1705 NE Pacific St
Seattle WA 98195-0001

Contact	Phone no.	Valid to
Charley Hernandez	302-633-7447	07/11/2011

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For Instruments Fax : 302-633-8953
For Consumables Fax : 302-633-8901
Email : LSCAinstrumentsales@agilent.com
For additional instructions, see last page

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UNIVERSITY OF WASHINGTON

OCEAN OBSERVATORIES INITIATIVE

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66394**
For:	UW Chem-Ocean Chemical Analysis Laboratory
Type:	Web
Date:	4/12/2011
Company:	Kathy Krogslund- UW Oceanography
Requested By:	GP

Notes:
Multiple analysis can be performed using this service

Technical Services

Marine Chemistry Laboratory

The Marine Chemistry Laboratory at the School of Oceanography provides marine and freshwater analytical services to the University and oceanographic communities. We are an accredited laboratory with the State of Washington. The lab specializes in the analyses of nutrients, total N and total P, salinity, chlorophyll, oxygen, DOC in aqueous samples, and OC in particulate samples. Prices and other analyses are listed below:

ANALYSIS	HOMEBASE OPERATIONS	SHIPBOARD ANALYSES
Salinity	Analyses are run on Guildline models 8400B and 8410 Portasal - Calibration is with IAPSO Standard Seawater	Analyses are run on Guildline models 8400B and 8410 Portasal - Calibration is with IAPSO Standard Seawater
Oxygen	Analyses are run using the Carpenter (modified Winkler) with a Metrohm 765 Dosimat buret	Analyses are run using the Carpenter (modified Winkler) with a Metrohm 765 Dosimat buret
Nutrients (phosphate, silicate, nitrate, nitrite, & ammonia)	Analyses and calibration follow the protocols of the WOCE Hydrographic Program using a Technicon AAII system	Analyses and calibration follow the protocols of the WOCE Hydrographic Program using a Technicon AAII system
Chlorophyll a and phaeopigments	Analysis is acetone extraction and fluorometric detection on a Turner Designs TD-700 fluorometer	
Dissolved Organic Carbon (aqueous samples)	Analysis is with a Shimadzu TOC-Vcsh DOC analyzer	
Total Organic Carbon, Nitrogen, and Hydrogen (solid samples)	Analysis is by Exeter Analytical CE-440 CHN analyzer	

Oceanography chemical analyses price list

Nutrients: (PO4, Si(OH)4, NO3, NO2, NH3) all ions included in base price	\$11.50 each \$17.00 each if dilution required Syringe filters for samples: \$2.00 each
Total N&P	\$12.50 each \$18.00 each if dilution required
Chlorophyll a	\$10.00 each
Dissolved Organic Carbon (DOC)	Filtered liquid sample \$17.00 each C clean filters \$.70 each C clean sample vial \$1.50 each
Particulate Carbon and Nitrogen (CHN)	On 25 mm filters \$27.75 each Sediment samples: \$38.75 each C clean filters \$.70 each
Salinity	\$11.50 each
TSS	\$11.50 each
Turbidity	\$5.75 each
Oxygen titrations	\$12.50 each 1L suite of the six oxygen reagents: \$420.00

Important notes:

- Add 15.6% to the total cost for any work done **not charged to a UW budget**.
- **Supplies** are not always available on short notice, so plan ahead and give them at least one full week's notice when requesting filters.
- **Logsheets** must be provided with the samples. They should include budget numbers, sample identification numbers, sampling locations, filtration volumes (where appropriate), and whether the sample contains fresh or marine water.
- Business is very good in the lab, so short **turnaround time** for sample analyses must be discussed with Kathy or Aaron ahead of time.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66395**
For:	UW Pooled Equipment
Type:	Web
Date:	4/12/2011
Company:	Jim Postel- UW Oceanography
Requested By:	GP

Notes:
Sampling equipment and storage vessel rental

Technical Services

Pooled Equipment

(April,2007)
Costs of pooled equipment are derived from the maintenance, calibration, parts, and supplies needed to keep the equipment operational.
NOTE: Outside renters add 15.6%.

Available pooled equipment includes:

Pooled Equipment

EQUIPMENT TYPE	CODE	DESCRIPTION	RATES
AUXILIARY	A01	Meter Wheel	$ 3.00 / Day
	A02A	Messengers, standard - $55.00 Replacement	$ 3.00 / Day
	A02B	Messengers, large - $60.00 Replacement	$ 3.00 / Day
	A03	Weight Tripper	$ 3.00 / Day
	A04	Wire Angle Indicator	$ 3.00 / Day
	A05	Lead Weights	$ 3.00 / Day
	A06	Grappling Hooks	$ 3.00 / Day
	A07	Miscellaneous Line	$ 3.00 / Day
	A08	Anchors	$ 3.00 / Day
	A09	Glass Floats	$ 3.00 / Day
	A10	Bronze Depressor	$ 3.00 / Day
BIOLOGICAL SAMPLING	B01A	Plankton Net, 1m Net, 216 Micron Mesh	$ 6.00 / Day
	B01B	Plankton Net, 0.5m Net, 500 Micron Mesh	$ 3.00 / Day
	B01C	Plankton Net, 0.25m Net, 34 And 64 Micron Mesh	$ 3.00 / Day
	B02	Biological Dredge	$ 15.00 / Day
	B03	Filter Rack & Vacuum Pump	$ 6.00 / Day
	BO4	Centrifuge	$ 6.00 / Day
	BO5	Deck Incubator	$ 3.00 / Day
CALIBRATION AND TEST	C01	Dynamometer (5000 Lb)	$ 6.00 / Day
	CO2A	Pressure Test Vessel	$ 87.69 / Hour
	CO2B	Pressure Test Vessel Outside UW	$ 120.70 / Hour
	CO3A	Test Tank Assisted	$ 72.65 / Hour
	CO3B	Test Tank Outside UW User	$ 100.00 / Hour
BATHYTHEMETRY/SURVEYING	D01	Side Scan Sonar (Klein 402)	$ 135.00 / Day
	D02A	EPC Recorder (3200)	$ 45.00 / Day
	D02B	EPC Paper	$ 42.00 / Roll
	D02C	EPC Stylus	$ 12.50 / Each
	D03	Uniboom Power Supply (Eg & G 230-1)	$ 45.00 / Day
	D04	Uniboom Transducer w/ sled	$ 45.00 / Day
	D05	Echo Sounder(Furuno)	$ 15.00 / Day
	D06	EPC Recorder (4600)	$ 45.00 / Day
	D07	Hydrophone Streamer 100 Element	$ 45.00 / Day
	D08	12khz PINGER	$ 45.00 / Day
	D09	ORE Transceiver	$ 45.00 / Day
	D10	Del Norte Amp.	$ 15.00 / Day
	D11	ORE Transceiver with transducer	$ 135.00 / Day
	D12	Teac Dat Recorder	$ 45.00 / Day
	D13	Trigger Box-Delay Unit	$ 15.00 / Day
	D14	Magnatometer Geometrix w/ winch	$ 135.00 / Day
	D15	Power Supply	$ 15.00 / Day
ELECTRICAL/ELECTRONIC	E01	Volt OHM Meter	$ 3.00 / Day

UNIVERSITY OF WASHINGTON

OCEAN OBSERVATORIES INITIATIVE

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66396**
For:	Camera Calibration Splash Cards
Type:	Web
Date:	4/12/2011
Company:	DSC Labs
Requested By:	GP

Notes:
Color calibration and white balance splash cards for HD and still cameras

White'nWarm - Handy Series

White'nWarm

Shoot neutral whites, by white balancing to "TrueWhite". Manufactured using DSC's unique technology, TrueWhite chips are spectrophotometrically neutral. Aligning to something that merely "looks" white can distort a camera's colorimetry.

Reproduce skin tones and colors with accuracy; make the most of your camera's alignment. White balancing to a DSC TrueWhite ensures that camera matrices reproduce as adjusted. To compensate for discontinuous light sources, such as fluorescents and HMIs, align cameras using a CamAlign CBGS (ColorBar/GrayScale) or an Ambi/Combi System lit by the same illuminant before final white balancing.

Save time and money in post. White balancing to a white chip with every change of lighting helps optimize image quality, expedite and facilitate video sweetening.

White and Warms are availible in Handy (10.0"x6.0") and Pocket (6.25" x3.75") sizes.

For more information on White and Warm Cards, please click **here.**

Weight: 0.50 kg

Price: $129

Add to Cart

If you have any questions or suggestions about this website, please contact:
"The Webmaster" <dsc@dsclabs.com> **Tel: 905.673.3211 Fax: 905.673.0929**
DSC Laboratories: 3565 Nashua Drive, Mississauga, ON L4V 1R1

Splash - Handy Series

Splash

12 Vector Colours - 5 Step Greyscale - Backfocus with Neutral white on reverse side

Comes with Splash Pouch and Lanyard for easy storage and travel.

Weight: 0.20 kg

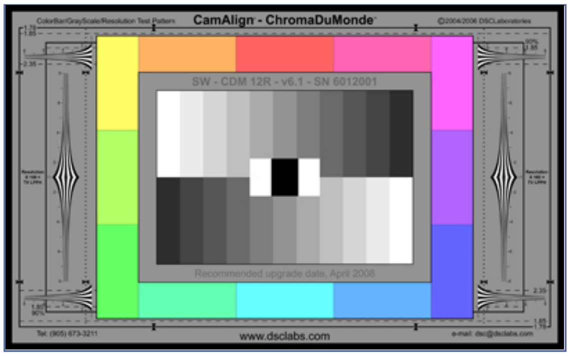
Price: $218

Add to Cart

If you have any questions or suggestions about this website, please contact:
"The Webmaster" <dsc@dsclabs.com> **Tel: 905.673.3211 Fax: 905.673.0929**
DSC Laboratories: 3565 Nashua Drive, Mississauga, ON L4V 1R1

ChromaDuMonde 12R - ChromaDuMonde

Store » **ChromaDuMonde** » ChromaDuMonde 12R



ChromaDuMonde 12R

Six vector colors, plus six intermediate (between vector) colors
Vertical and Horizontal Resolution Trumpets to 800 LPPH
DSC 11-step crossed grayscales, 100 IRE white and true black chips
16:9 (1.78) and 4:3 framing bowties plus motion picture framing lines for 2.35, 1.85 and 90% of 1.85.

For more information on the ChromaDuMonde Series, please click **here.**

Weight: 1.00 kg

Price: $1058

Size: Standard 21.3" x 13"
CamFolder: No Yes
CamStand: No Yes
Cavity Black: No Yes
Table Top Base Stand WITH CAMSTAND ONLY: No Yes
MAXI & SUPER MAXI ONLY - 3D CaviBlack: No Yes
MAXI & SUPER MAXI ONLY - Road Travel Case: No Yes
MAXI & SUPER MAXI ONLY - Custom Manfrotto Stand: No Yes

Add to Cart

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"The Webmaster" <dsc@dsclabs.com> **Tel: 905.673.3211 Fax: 905.673.0929**
DSC Laboratories: 3565 Nashua Drive, Mississauga, ON L4V 1R1

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66397**
For:	Heavy Lift Winch System
Type:	Budgetary Quote/Email
Date:	3/4/2011
Company:	Dynacon
Requested By:	Eric Boget

Notes:
Large drum heavy lift winch. Spooler is also needed and was not quoted, however attached email includes an estimate from a recent APL purchase of similar unit. Additional funds will be need to integrate the two units.

DYNACON, Inc.
WINCHES-HANDLING SYSTEMS
831 Industrial Blvd.
Bryan, Texas 77803

Office 979-823-2690
Facsimile: 979-823-0947

QUOTATION

TO: Applied Physics Lab
University of Washington
1013 NE 40th Street
Broussard, LA 70518

DATE: 4 March 2011

QUOTE: Q1103202.UOW

Attention: Eric Boget
Email : boget@apl.washington.edu

ITEM	Qty	DESCRIPTION	Unit Price	Extension
1	1	DYNACON **Modified Model 421** General Purpose Winch with the following features:	US $ 340,000.00	US $ 340,000.00

- **SWL 8** metric tonnes @ full drum diameter
- Heavy Air Lift Valve Package
- Electro-Active levelwind with vertical guide rollers
- 100 HP EHPU with 100cc pump, non-hazardous
- 460 VAC +/- 10%, 3 phase, 60Hz power required
- Non-hazardous location with 7.62 m (25 ft.) interconnect hoses
- Local Control with 7.62 m (25 ft.) interconnect cable
- Designed to accept slipring inside 146.05 mm (5.75 in) I.D. shaft
- Auxiliary flow, 121.3 lpm (32 gpm) at 206 bar (3000 psi)
- Drip Pans
- Water/Oil heat exchanger
- Low Temperature Steel (-20° C)
- Steel Hose Ends & Fittings with corrosion inhibitor
- Variable Displacement Motor with Shift Circuit
- Oil Immersion Heater

Winch Performance Summary

- Capacity: 3,200 meters of 1.125 inch diameter cable on 16 layers with a drum 50 inches wide with partition for connector approx 7 ½” wide (with pass through in flange)

Overall Shipping Dimensions:
Length: 3.13 meters (123 1/4 inches)
Width: 2.61 meters (103 inches)
Height: 2.68 meters (105 1/2 inches)

PRICING NOTES:

1) Pricing for other available options can be provided under separate DYNACON Quotation.
2) Pricing offered is valid only for the Payment Terms stated below.
3) Pricing excludes slipring, rotating and stationary J-boxes, umbilical and shipboard power cable.

TERMS:	30% due with order 30% due 150 days prior to FAT 30% due 30 days prior to FAT 10% due at FAT
COLOR:	DYNACON Blue unless otherwise specified at time of order.
CABLE:	Customer to provide Cable Diameter and Manufacturing Tolerance with Purchase Order
FREIGHT:	Ex Factory, Bryan, Texas
DELIVERY:	26 weeks after Receipt of Order, pending availability of components at time of order
QUOTE VALIDITY:	30 days
WARRANTY:	See attached DYNACON, Inc. Warranty Policy

SUBMITTED BY:

____
Dennis Brunson
Sr. Vice President, C.O.O.
DYNACON, Inc.

DYNACON, Inc.
831 Industrial Blvd.
Bryan, Texas 77803
(979) 823-2690

1. DYNACON, Inc. warrants that:

   1.1 The Product(s) Covered shall be free from all defects resulting from faulty design, faulty material, faulty workmanship, improper assembly or incompatibility of components. Only equipment supplied by DYNACON as a part of this system is included under this warranty. The U.S. dollar amount covered by this warranty shall not exceed the total value of the DYNACON equipment supplied under the sales agreement.

   1.2 The Product(s) Covered will conform to such drawings and specifications as defined by the DYNACON, Inc. sales agreement with Buyer as applicable to said Product(s).

2. Subject to Paragraphs 4 and 5, the warranties referred to herein shall extend for each Product(s) Covered for a period of one (1) year from the date of shipment from DYNACON facility or six (6) months after commencement of system operation, whichever occurs first, of each Product(s) Covered.

3. The warranties provided for in this Warranty shall not apply to equipment or systems becoming defective or to equipment or systems failures, including failures in performance, which result from:

   3.1 The Buyer not complying with DYNACON's reasonable written instructions for the storage, operation, maintenance and repair of the Product(s) Covered;

   3.2 Alterations or replacements by the Buyer in the Product(s) Covered which are not approved in writing by DYNACON, provided that such approval shall not be unreasonably withheld;

   3.3 Normal wear and tear;

      3.3.1 Wear items excluded include, but not limited to items listed in Paragraph 13.

      3.3.2 Breakage and defects arising through the negligence or carelessness of any person on board a Vessel during the warranty period;

   3.4 Operation or failure of any machinery or equipment or system not supplied by DYNACON.

4. Subject to Paragraph 5 in the event that there is a defect in any part of the Product(s) Covered resulting from faulty design, faulty material or faulty workmanship during the warranty period, the warranty on that part shall be extended for a period equal to the period of the breakdown but this extension shall only apply to the defective part or to such other equipments as are rendered inoperative during the duration of the breakdown as a direct result of the defective part, and in no event shall such period extend beyond one(1) year from shipment from DYNACON facility of such Product(s) Covered.

5. Where the Product(s) Covered becomes inoperative while DYNACON corrects anything set out in Paragraph 1, the duration of DYNACON's warranty under this Warranty Policy shall be extended for a period of time equal to the period of time during which that the Product(s) Covered is inoperative, and in no event shall such period extend beyond one (1) year from shipment from DYNACON facility of such Product(s) Covered.

6. DYNACON shall transfer and assign to the Buyer any and all warranties and the benefits thereof from any manufacturer or supplier extending beyond the duration of the warranties provided in this Warranty Policy, without in any way extending DYNACON's warranties. A list of any such warranties shall be provided to the Buyer by DYNACON.

7. Subject to Paragraphs 2,4,5 and 8, DYNACON, if requested by the Buyer to do so at any time within the warranty periods specified in Paragraph 2 or extensions thereof, shall replace or make good at its own expense any Product(s) Covered, or any parts thereof which becomes defective or which fails to conform to the DYNACON, Inc. sales agreement with Buyer as a result of faulty design, faulty material or faulty workmanship; provided the Buyer has given written notice to DYNACON of such defect or failure within 60 Business Days of it becoming apparent and provided such defect or failure is covered by the warranties in Paragraph 1 and provided DYNACON is given the opportunity to correct such defect or failure after said notice.

8. DYNACON shall bear all reasonable ground transportation costs for transporting any defective Product(s) Covered, or part thereof, between its location and DYNACON's facilities. Where, in the opinion of the Buyer, it is not expedient to remove such defective Product(s) Covered, or part thereof, from its location, DYNACON shall replace or make good the defective Product(s) Covered, or part thereof, at such location, and shall be paid the actual costs incurred in so doing (including reasonable traveling and living expenses) with no allowance thereon by way of profit, less a sum equivalent to the cost of making good the defective Product(s) Covered had it been made good at DYNACON's facilities.

9. DYNACON shall, for all warranty claims arising during the warranty period or periods as specified within Paragraph 2, at its expense,

   9.1 Replace any manuals or other documents or portions thereof as necessary that are not accurate or that otherwise do not meet the DYNACON, Inc. sales agreement with Buyer.

10. After delivery of the Product(s) Covered and with the prior written consent of DYNACON, the Buyer or its representatives may conduct repairs to the Product(s) Covered provided repairs are made by qualified personnel;

    10.1 The repairs referred to in paragraph (10), if carried out properly and in accordance with any specific instructions given by DYNACON in the consent referred to in (10) above, will not in any respect diminish or vitiate any of DYNACON's obligations under this Warranty;

    10.2 The repairs referred to in subparagraph (10) are considered to be pre-approved in writing by DYNACON to the extent and if included in the maintenance schedules delivered under this Warranty. Repairs and repair procedures not described in these schedules require prior written consent of DYNACON which consent shall not be unreasonably withheld.

11. In the event that the Buyer requests DYNACON to perform repair or correction work in respect of Product(s) Covered, or part thereof, which is subsequently shown not to be covered by the warranties stipulated or referred to in this Warranty, the Buyer shall reimburse DYNACON its reasonable cost of verifying conformity or for repair or correction of such Product(s) Covered, and in addition shall pay DYNACON a fair and reasonable profit thereon.

12. DYNACON shall appoint a representative to act as liaison with the Buyer to deal with any defects arising during the warranty period.

13. Subject to Paragraph 3.3.1, parts to be considered excluded wear items are as follows:

    Fuses, Relays and light bulbs
    ACME nuts and flanges
    Caliper brake pads
    Switch contact blocks
    Hydraulic oil, gear oil, grease and lubricants in general
    Fasteners required for bolting to ship's deck for installation
    Protective boots for switches
    Hydraulic hose assemblies - after six (6) months
    Fluid disconnects - after six (6) months
    Water/Oil heat exchanger - after six (6) months
    Roller Chain - after six (6) months
    Filter Elements (oil, other)

DYNACON, INC.
WINCHES - HANDLING SYSTEMS

Model 421
General Purpose ROV Winch

Performance Specifications

1. Ratings and Capacity		
1.1	Safe Working Load	78,463 N (8,000 Kg, 17,640 lbs.) at full drum
1.2	Maximum Line Pull	97,800 N (10,000 Kg, 22,000 lbs.) at full drum (equal to 1.25 times Safe Working Load)
1.3	Line Speed	0.50 m/s (30 mpm, 100 fpm) at full drum, 60 Hz
1.4	Drum Capacity	1,704 meters (5,590 ft.) of 46 mm (1.81 in.) diameter umbilical
2. Winch Drum Dimensions		
2.1	Drum Core Diameter	1,168 mm (46 in.)
2.2	Drum Core Width	1,619 mm (63¾ in.)
2.3	Drum Flange Diameter	2,184 mm (86 in.)
3. Overall Dimensions		
3.1	Length	4,242 mm (167 in.)
3.2	Width (across drum face)	2,514 mm (99 in.)
3.3	Height	3,035 mm (119½ in.)
3.4	Weight (without cable, including power unit)	8,707 Kg (19,200 lbs.)

Standard Features

- 56 kW (75HP) Electro-Hydraulic Power Unit with Soft Start Motor
- EHPU supplied with 7.61meter (25 ft.) interconnect hoses
- DnV Certified Lift Frame according to Rules for Certification of Lifting Appliances 1994
- Designed to accept slipring inside 146 mm (5¾ in) I.D. shaft with up to 1,016 mm (40 in.) in length housed internally
- Road transportable
- Auxiliary hydraulic flow, 121 lpm (32 gpm) at 138 bar (2,000 psi)
- 5 section directional control valve fro Auxiliary Circuits
- Water/Oil Heat Exchanger

Options

- Grooved Drum Liner
- Overhead right-angle levelwind
- Remote Control with 15 meter (50 ft) interconnect cable
- Stainless Steel Hose Ends and Adapters
- Operator Platform
- Drip Pans for Winch and Levelwind
- Forced Air-Over-Oil Heat Exchanger
- Ratings for Hazardous Location
- Full DnV Certification

Contact us for pricing, terms, warranty information, lease arrangements and delivery

831 Industrial Blvd., Bryan, Texas 77803
Telephone: (979) 823-2690 Facsimile: (979) 823-0947
World Wide Web: http://www.dynacon.com

Contact the Sales Department for a specification sheet of this system in PDF format.

Date: Thu, 14 Apr 2011 19:29:33 -0700
Subject: Re: Winch needs for RSN vertical moorings
From: "Eric Boget" <boget@apl.washington.edu>
To: "Giora Proskurowski" <giora@uw.edu>
Cc: "Vern Miller" <vern@apl.washington.edu>,
"Giora Proskurowski" <giora@uw.edu>
Reply-To: boget@apl.washington.edu

Giora,
There wasn't much time to get a winch quote. It would be nice to explore the traction winch option further. Vern's primary concern is deck space. The traction winch would need to be designed with footprint similar to the drum winch, some kind of turning sheave to allow the spooler / reel stand to be place outboard of the traction winch (stbd side) and what range of cable or line diameter can be accommodated. I got a quote for a powered spooler and seem to recall it was $20-30K range but don't have notes with me.
Eric

> Eric-
>
> I remember you mentioning that you were going to be away right about
> now...
>
> Lets plan on a more lengthy discussion in early May, but there are a
> couple of budget issues that need to be dealt with right now.
>
>
>
> giora
>
>
>
>
>
> Eric Boget wrote, On 4/13/11 8:16 PM:
>> Giora,
>> Vern and I are down in Florida for another experiment. We will not
>> return
>> until the end of April. We were discussing winches the other day. We
>> have a quote for a large drum winch. We would like to look into size
>> and
>> cost of traction winches. Can we discuss in early May? Otherwise, we
>> will need to communicate via email.
>> Eric
>>
>>> Vern, Eric
>>>
>>> I'm just looking for a quick chat to clarify a couple of issues
>>> surrounding the winch needs for the vertical mooring deployments.
>>>
>>> -timeline for decision
>>> -timeline for acquisition
>>> -type
>>>

>>> Are either of you around today for a couple of minutes on the phone
>>>
>>> thanks
>>>
>>>
>>>
>>> --
>>>
>>> giora
>>>
>>> ^^^
>>>
>>> Dr. Giora Proskurowski
>>> Project Scientist
>>> Regional Cabled Observatory of NSF's OOI
>>> University of Washington
>>>
>>> giora@uw.edu
>>> http://ooi.washington.edu
>>>
>>> w 206.685.3507
>>>
>>> ^^
>>>
>>
>>
>> Eric Boget
>> Applied Physics Laboratory
>> University of Washington
>> 1013 NE 40th Street
>> Seattle, WA 98105
>> (206) 685-1971
>> boget@apl.washington.edu
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> giora
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> Dr. Giora Proskurowski
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> w 206.685.3507
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>

Eric Boget

Applied Physics Laboratory
University of Washington
1013 NE 40th Street
Seattle, WA 98105
(206) 685-1971
boget@apl.washington.edu

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66398**
For:	Isobaric Gas Tight Sampler
Type:	Description and notes from personal communication
Date:	3/4/2011
Company:	Jeff Seewald- WHOI
Requested By:	GP

Notes:
Isobaric Gas Tight samplers are required for sampling of vent fluids. Advantage of these samplers is that they capture the liquid and volatile phases of the fluid.

Emailed Jeff Seewald 11 Mar 2011
Followed with a phone call 12 Mar 2011

Last unit built in 2007.

Estimated cost approximately $25000 per unit (for 3 units)
This could come down if a couple more could be manufactured at the same time... there is interest from Bill Seyfried, Wolfgang Bach, so this could be a possibility
Terry Hammer was mechanical engineer, electronics were Steve Libertore and Al Bradley, software wasSteve Libertore and Al Bradley and modified by Giora Proskurowski
Cost could come down if ICL comms were lost

    -This would not be a problem, in fact would be a benefit
    -Hardwired to vehicle

Other costs associated with this setup are not included (basket holsters, sampling gear, consumable hardware, tools, shipping crates, etc.)
To avoid liability issues these would probably be built outside of WHOI domain, using Terry as a consultant

PERGAMON

Deep-Sea Research I 49 (2001) 189–196

DEEP-SEA RESEARCH
PART I

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Instruments and methods

A new gas-tight isobaric sampler for hydrothermal fluids

Jeffrey S. Seewald*, Kenneth W. Doherty, Terence R. Hammar, Stephen P. Liberatore

Woods Hole Oceanographic Institution, MS 4, Woods Hole, MA 02543, USA

Received 26 January 2001; received in revised form 17 July 2001; accepted 17 July 2001

Abstract

A new gas-tight isobaric sampler for the collection of hydrothermal fluids venting at the seafloor has been designed, constructed, and tested at a ridge-crest vent site. The new device is constructed of chemically inert titanium, is gas-tight to 450 bar and can be used to sample fluids with temperatures up to 400°C. Compressed gas is used to maintain the sample at seafloor pressure before and during sample withdrawal onboard ship, allowing subsampling without degassing the fluid remaining in the sampler. This feature eliminates the need to collect separate gas-tight and major element samples since a single fluid sample can be analyzed quantitatively for major, trace, semi-volatile, and volatile components. The sampler fill rate is regulated to minimize entrainment of ambient seawater during collection of fluids from environments characterized by low fluid flow such as diffuse hydrothermal vents. In addition to deployment at the ridge-crest, the samplers can be used to collect gas-tight samples from other subseasurface environments such as hydrocarbon seeps, areas of methane-gas hydrate formation, cold seeps associated with serpentinites, regions of groundwater egress to the oceans, and the water column. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Hydrothermal fluid sampler; Vents; Dissolved gases; Instrumentation

1. Introduction

Quantitative chemical analysis of ridge-crest hydrothermal fluids is essential to constrain physical, chemical, and biological processes regulating the exchange of heat and mass between seawater and the oceanic crust. In addition to producing mineral deposits and regulating the composition of seawater over geologic time, hydrothermal activity at mid-ocean ridges creates chemical environments that support large biological communities. Since vent fluids can attain temperatures in the vicinity of 400°C, may be extremely gas-rich, and are highly corrosive due to their high salinity and low pH, the design of a suitable sampling device presents significant engineering challenges. Fluids have been collected from seafloor hydrothermal systems with a variety of samplers that can be deployed from remotely operated vehicles and occupied submersibles. In addition to the most widely used 755 ml titanium syringe bottle commonly referred to as the "major" sampler (Von Damm et al., 1985a; Edmond et al., 1992), a multi-chamber syringe device has been used by some researchers

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E-mail address: jseewald@whoi.edu (J.S. Seewald).

PII: S0967-0637(01)00046-2

(Tsunogai et al., 1994; Ishibashi et al., 1995). Gas-tight samplers that collect fluids by filling an evacuated titanium sample chamber (Edmond et al., 1992) have also been deployed at numerous locations (Butterfield et al., 1990; Lilley et al., 1993; Butterfield et al., 1994; Von Damm et al., 1997). Time series fluid samples from diffuse vents have been collected with autonomous devices known as Medusa (Schultz and Elderfield, 1997) and OsmoSamplers (Wheat et al., 2000). The OsmoSamplers rely on an osmotic gradient to fill a capillary tube and have proven to be very effective in obtaining continuous time-resolvable samples from hydrothermal systems.

Despite the enormous quantity of high quality data that have been collected with existing technology, there are limitations associated with each sampler that reduces their effectiveness for some applications. For example, non-gas-tight devices such as the "major" samplers are not well-suited for determining the abundance of dissolved volatile and semi-volatile species when their concentrations exceed saturation at room temperature and pressure (cf. Von Damm et al., 1985b; Edmond et al., 1992). The existing gas-tight samplers have successfully circumvented this problem for volatile species, but the associated extraction process does not allow for the analysis of semi-volatile low molecular weight organic compounds, pH, and alkalinity. In addition, the relatively rapid fill rates of the existing "major" and gas-tight samplers can result in a substantial entrainment of ambient seawater when sampling diffuse vent areas characterized by low flow rates. The NOAA/PMEL manifold attachment for use with the "major" and gas-tight samplers (Massoth et al., 1989) represents an attempt to minimize seawater entrainment but results in artificially low metal concentrations for high temperature vent fluids due to their precipitation and loss within the manifold dead volume (Edmond et al., 1992).

To address these issues, we have designed and constructed a gas-tight isobaric fluid sampler that allows regulation of the fill rate. A key feature of the new device is that fluid within the sample chamber is maintained at seafloor pressure during sample withdrawal facilitating an almost unlimited number of analytical techniques that can be conducted on subsamples without degassing the remaining fluid. As a result, a single fluid sample can be fully characterized in terms of its major, trace, semi-volatile and volatile components. Although designed to withstand the harsh physical and chemical environments typical of ridge-crest hydrothermal systems, the sampler can be used to collect gas-tight samples from a variety of other subseasurface environments such as hydrocarbon seeps, areas of methane-gas hydrate formation, cold seeps associated with serpentinites, areas of groundwater discharge to the oceans, and the water column.

2. Instrument design

The sampler is 45 cm long without the snorkel attached, and weighs approximately 10 kg in air and 6 kg in seawater (Fig. 1). The sample volume is currently 150 ml but can be modified by constructing longer or shorter sample and accumulator chambers without the requirement of changes to the valves and actuating mechanism. Sample degassing before and during sample extraction is prevented by using a compressed gas to maintain the fluid at seafloor pressures. Prior to deployment, the sample and accumulator pistons are positioned against the snorkel inlet and coupling, respectively (Fig. 2a). The snorkel and sample valve dead volume (approximately 4 ml), and sample chamber on the back side of the sample piston are filled with filtered bottom seawater while the accumulator chamber on the backside of the accumulator piston is filled with compressed nitrogen (Fig. 2a). The nitrogen pressure is adjusted to 10% of the hydrostatic pressure at the sampling depth. Samples are collected by inserting the snorkel in the fluid flow with a submersible's manipulator arm and then opening the motor actuated sample valve. The fluid entering the sampler forces the sample and accumulator pistons to the opposite ends of their respective chambers (Fig. 2b). During this process, the rate at which hydrothermal fluid enters the sampler is regulated by the Visco-Jet® orifice, which restricts the flow of filtered seawater through the coupling. The fill

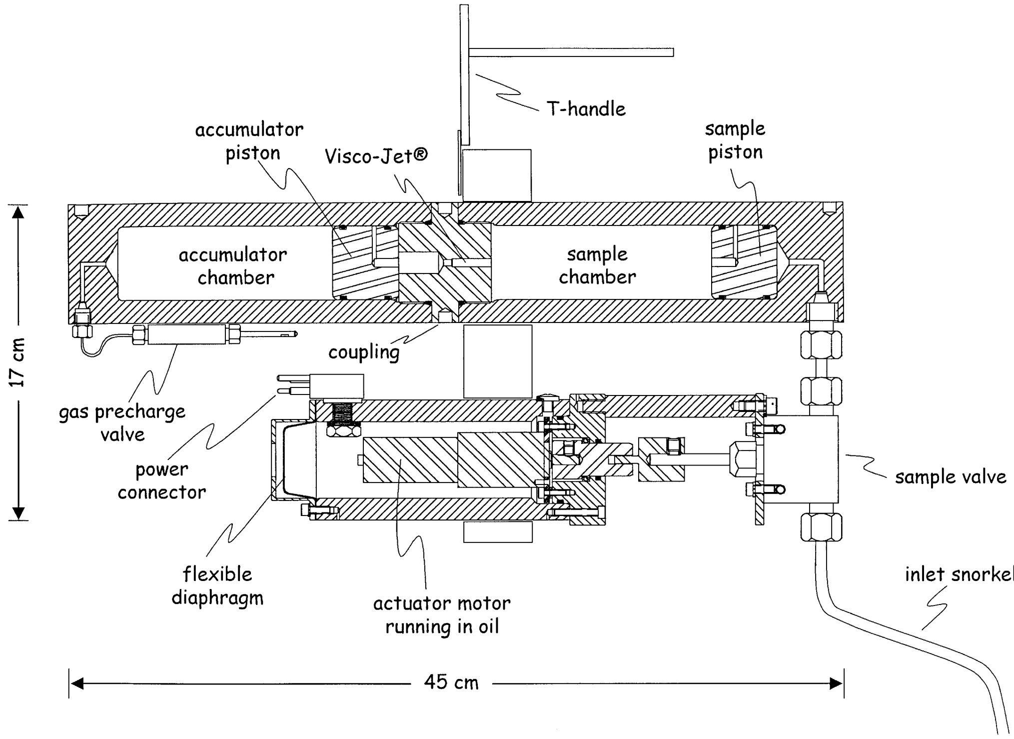


Fig. 1. Schematic illustration of a new gas-tight isobaric fluid sampler. The unit weighs 10 kg in air, 6 kg in seawater, and is 7 cm wide.

rate can be adjusted to almost any value prior to a dive by changing the Visco-Jet® orifice size. A sample rate of 1 ml/s requires approximately 2.5 min to fill the 150 ml sample chamber and is ideal for most hydrothermal systems.

After the sampler has filled and attained internal pressure equilibrium, the sample valve is closed. The internal volume of the accumulator chamber is 2% less than the internal volume of the sample chamber to ensure that a small fraction of the added seawater remains in the sample chamber on the backside of the piston to prevent it from "bottoming out" against the coupling (Fig. 2b). Similarly, the nitrogen precharge gas is at seafloor pressure after sampling and prevents the accumulator piston from contacting the end of the accumulator chamber. Accordingly, the potential for sample leakage is minimized because both pistons are "floating" in their chambers with no differential pressure across the perfluoroelastomer piston o-rings. The compressed nitrogen in the accumulator buffers internal pressure fluctuations caused by cooling of the hydrothermal fluid or external temperature and pressure changes during transport from the seafloor to the seasurface.

Extraction of the fluid sample onboard ship is achieved by removing the snorkel and attaching a micrometering valve in series with the sample valve (Fig. 2c). A high pressure liquid chromatography (HPLC) pump equipped with a pressure gauge is attached to the gas precharge valve. After the sample valve is opened, fluid aliquots are withdrawn through the micrometering valve while water is simultaneously pumped through the gas precharge valve to maintain constant pressure within the sampler. Since the internal pressure does not decrease during subsampling, a large number of fluid aliquots for replicate and different analyses can be withdrawn without degassing the remaining fluid. For analysis of trace gases that have a significant concentration in air, the volume between the micrometering and sample valves can

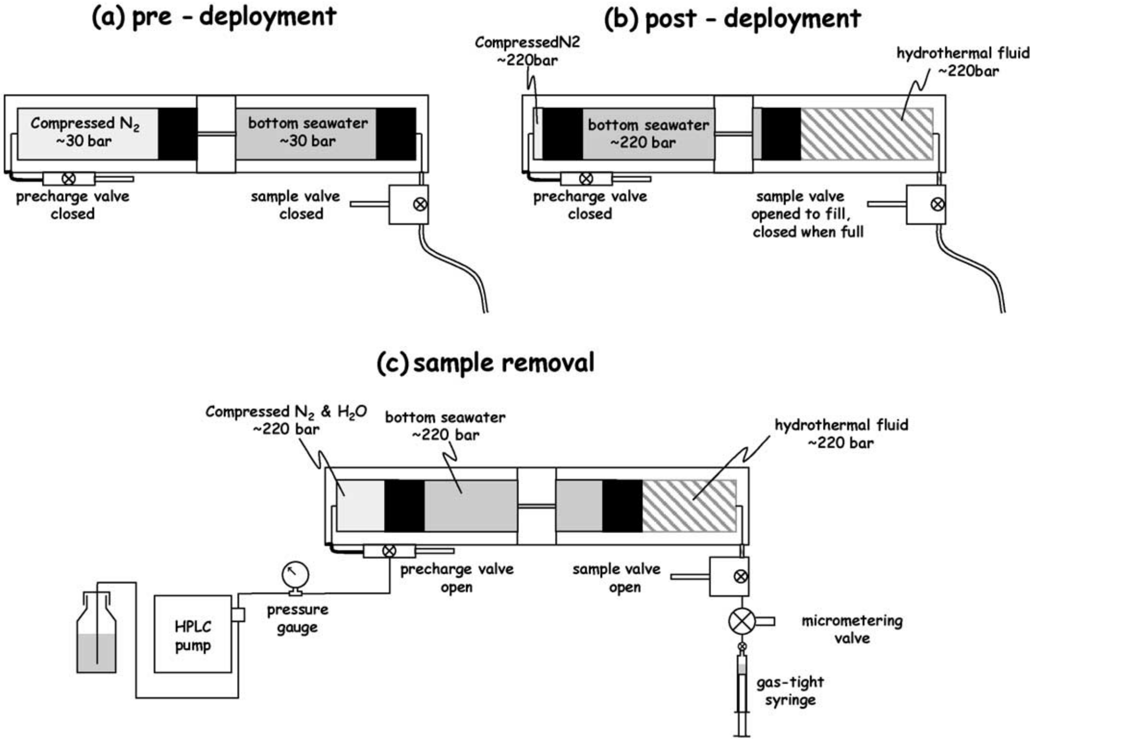


Fig. 2. Schematic illustration of a gas-tight isobaric fluid sampler: (a) before deployment, (b) after deployment, and (c) configured for the removal of sampled fluid.

be evacuated prior to fluid withdrawal by attaching a vacuum pump to the micrometering valve. After complete removal of the fluid sample, the sampler is cleaned by removing the sample chamber from the coupling, extracting the sample piston, and flushing the sample chamber and valve with the appropriate solvents/cleaning agents. The simplicity of this process allows rapid turnaround (approximately 30 min/sampler) for subsequent deployments.

The sample valve actuating mechanism consists of a DC electric motor with precious metal brushes running at ambient pressure in a silicone oil-filled plastic housing. A timing circuit in the control box located inside the submersible ensures that the sample valve opens completely during deployment. Power and valve control is presently provided by a hardwire connection to the submersible. This connection will be eliminated in the near future by the addition of a battery pack and an inductively coupled link (ICL) that allows instrument control via non-contact serial communication (Bradley et al., 1995; Fornari et al., 1997). The ICL will also permit real time temperature measurement during sampling (Fornari et al., 1997). Closing the valve to specified torque settings is achieved by monitoring motor current. This design contrasts with that of the existing "major" and gas-tight samplers that utilize sample valves actuated by a hydraulic ram located on a submersible's manipulator arm. The motor driven system eliminates hydraulic ram-induced sampler movement or "cocking" that can inadvertently relocate the snorkel out of the hydrothermal fluid flow and result in seawater entrainment.

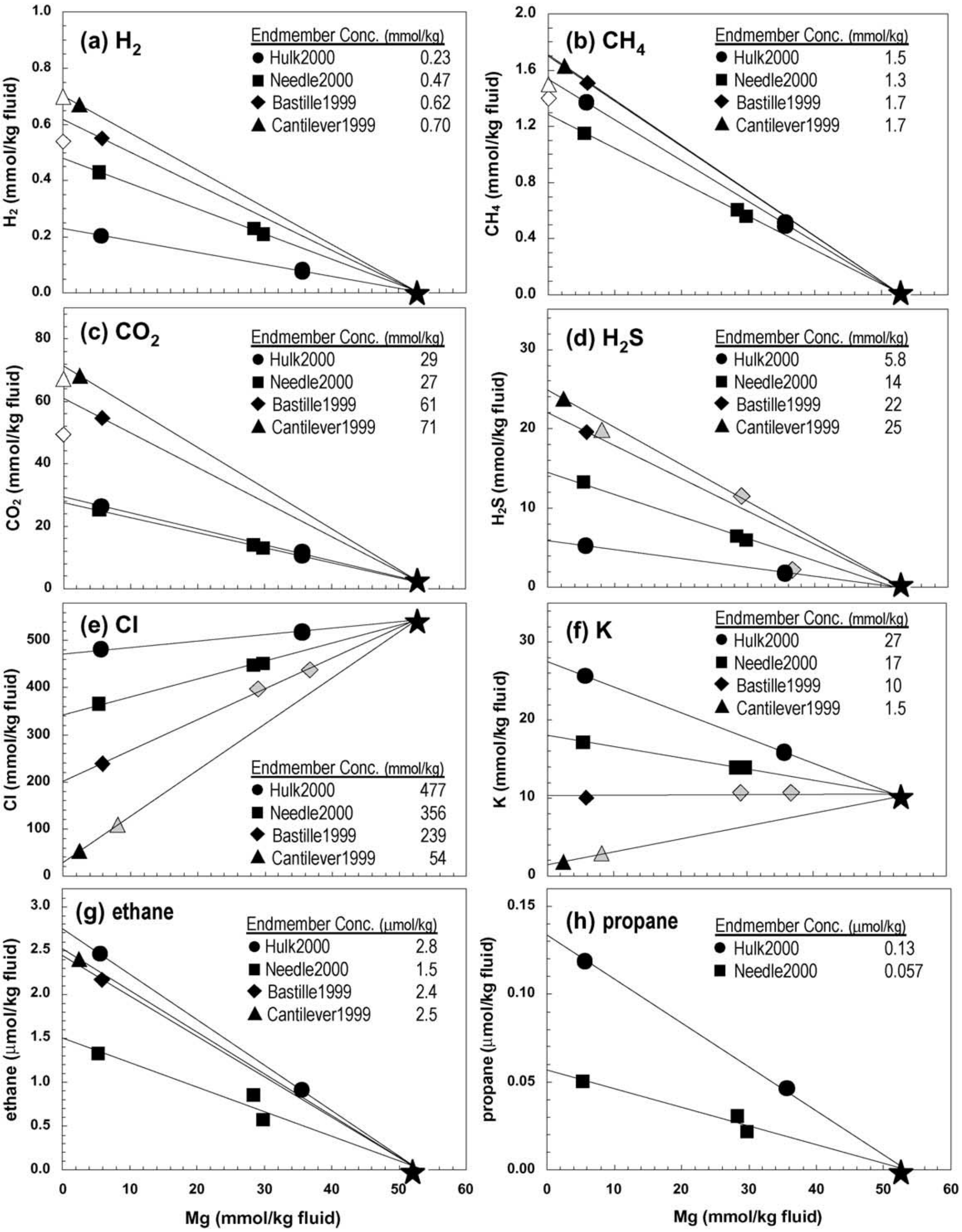
Surfaces in contact with a fluid sample include the grade 2 titanium sample valve, pistons and snorkel, 6AL4V-ELI titanium alloy sample chamber, Teflon sample valve packing, and perfluoroelastomer (KALREZ®) piston o-rings. Titanium and titanium alloy were chosen for the valving and sample chamber because of their resistance to corrosion by hot chloride-rich fluids, high strength, and low mass. The sample and accumulator chambers and pistons are electrolytically coated with a layer of titanium oxide (tiodized) to minimize the potential for titanium oxidation and associated H_2 production during contact with hot fluid samples. In addition, the titanium oxide surface reduces galling if the piston were to inadvertently contact the cylinder walls during an o-ring failure. The sample and gas precharge needle valves are commercially available items with replaceable needles (Autoclave Engineers Inc.). The maximum pressure for safe operation of the sampler is 450 bar. The maximum operational fluid temperature is presently unknown but is limited by the thermal stability of the Teflon valve packing and KALREZ® piston o-rings. Since the sampling rate is generally slow and hot fluid entering the sample chamber is rapidly cooled by the large thermal mass of the sampler, vents with temperatures substantially hotter than the recommended limits for Teflon (232°C) and perfluoroelastomer (343°C) can be sampled. We have sampled 380°C fluids with no visible deterioration of the valve packing or o-rings.

3. Example results

The isobaric fluid samplers have proven to be extremely reliable and rugged during more than 40 deployments at vent fields located along the northern Juan de Fuca Ridge. A comprehensive analytical strategy resulted in a quantitative determination of volatile, semi-volatile, and non-volatile inorganic and organic aqueous species in each sample. For example, dissolved H_2 and CH_4 abundances were determined by withdrawing a known volume of fluid into a gas-tight syringe, performing a headspace extraction in the syringe, and injecting the headspace gas into a gas chromatograph. Fluid aliquots were also withdrawn into evacuated 6 mm Pyrex® tubes with gas-tight valves and quantitatively analyzed on shore in a purge and trap device for the abundance of CO_2 and low molecular weight hydrocarbons. Aqueous H_2S concentrations were determined gravimetrically following acidification of the sample with phosphoric acid and precipitation of evolved H_2S as Ag_2S in an $AgNO_3$ solution. Major and trace non-volatile inorganic aqueous species were analyzed by ion chromatography and inductively coupled plasma-optical emission spectroscopy.

Fig. 3 shows the concentrations of selected volatile and non-volatile aqueous species as a function of measured Mg concentrations in hydrothermal fluids collected at the Main Endeavour Vent Field, northern Juan de Fuca Ridge in September 1999 and July 2000 (see Butterfield et al., 1994 for a detailed description of this location). The composition of hydrothermal fluids venting at the seafloor is determined by extrapolating the measured concentrations of individual species to zero Mg using a least squares linear regression of vent fluid and seawater compositions. This process removes compositional variations in samples caused by entrainment of Mg-rich seawater and yields, what is commonly referred to as, an endmember composition. Although a zero Mg hydrothermal fluid has never been sampled because all samplers have finite dead volumes that are filled with ambient seawater, the approach is justified by laboratory experiments demonstrating near quantitative removal of Mg from seawater during hydrothermal seawater–basalt interaction at temperatures, pressures, and water/rock ratios that exist in high temperature ridge-crest hydrothermal systems (Bischoff and Dickson, 1975; Mottl and Holland, 1978; Seyfried and Bischoff, 1981). The dead volume in the sampler described here is dependent on snorkel length but is typically 4 ml which would correspond to a minimum Mg concentration of 1.6 mmol/kg if there were no seawater entrainment during sample collection.

In general, vents at which more than one gas-tight sample were collected on a given date are characterized by a strong linear correlation between the species of interest and Mg, indicating a conservative mixing of hydrothermal fluid and entrained seawater. The strong correlation for dissolved H_2 is particularly encouraging because it indicates that oxidation of the titanium sampler by hydrothermal fluid was not significant.


(a) H_2
Endmember Conc. (mmol/kg)
Hulk2000 0.23
Needle2000 0.47
Bastille1999 0.62
Cantilever1999 0.70
H_2 (mmol/kg fluid)
(b) CH_4
Endmember Conc. (mmol/kg)
Hulk2000 1.5
Needle2000 1.3
Bastille1999 1.7
Cantilever1999 1.7
CH_4 (mmol/kg fluid)
(c) CO_2
Endmember Conc. (mmol/kg)
Hulk2000 29
Needle2000 27
Bastille1999 61
Cantilever1999 71
CO_2 (mmol/kg fluid)
(d) H_2S
Endmember Conc. (mmol/kg)
Hulk2000 5.8
Needle2000 14
Bastille1999 22
Cantilever1999 25
H_2S (mmol/kg fluid)
(e) Cl
Endmember Conc. (mmol/kg)
Hulk2000 477
Needle2000 356
Bastille1999 239
Cantilever1999 54
Cl (mmol/kg fluid)
(f) K
Endmember Conc. (mmol/kg)
Hulk2000 27
Needle2000 17
Bastille1999 10
Cantilever1999 1.5
K (mmol/kg fluid)
(g) ethane
Endmember Conc. (μmol/kg)
Hulk2000 2.8
Needle2000 1.5
Bastille1999 2.4
Cantilever1999 2.5
ethane (μmol/kg fluid)
(h) propane
Endmember Conc. (μmol/kg)
Hulk2000 0.13
Needle2000 0.057
propane (μmol/kg fluid)
Mg (mmol/kg fluid)
Mg (mmol/kg fluid)

Comparison of endmember H_2, CH_4, and CO_2 concentrations in fluids collected using our sampler with values determined in fluids collected at the same time using existing gas-tight samplers (Lilley, personal communication) shows reasonable agreement (Fig. 2a–c). The larger discrepancies associated with the Bastille data likely reflect the high degree of uncertainty associated with endmember concentrations calculated for the existing gas-tight sampler fluids due to a substantial seawater entrainment ($Mg \geqslant 39$ mmol/kg; Lilley, personal communication).

Fluids were also collected with "major" samplers and processed in an identical manner to the isobaric sampler fluids to allow a direct comparison. Measured concentrations of non-volatile species in fluids from both samplers show excellent agreement (Fig. 3). In the case of H_2S concentrations measured in gas-rich fluids collected at Bastille, however, data for the "major" sampler fluids are characterized by a greater degree of scatter relative to data for the isobaric sampler fluids (Fig. 3). The higher uncertainty is the result of H_2S degassing before and during withdrawal of fluids from the "major" samplers. Since sample degassing creates H_2S-depleted fluid and H_2S-rich bubbles, measured H_2S concentrations that are both above and below the actual values may be obtained if liquid and bubbles are not collected representatively during subsampling. Degassing of fluids in the major samplers has been noted previously (Von Damm et al., 1985b; Edmond et al., 1992) and occurs when the concentration of a volatile species exceeds its aqueous solubility at laboratory temperature and pressure causing the formation of a gas phase. Bubble formation affects the aqueous concentrations of all volatile species regardless of their saturation state because they partition efficiently into the gas phase. Although H_2S concentrations did not exceed saturation at laboratory conditions in samples collected at Bastille, measured CO_2 concentrations exceeded saturation during sample withdrawal resulting in the formation of CO_2-rich bubbles within the sampler and gas phase partitioning of other volatile species such as H_2S.

In summary, the gas-tight isobaric hydrothermal fluid sampler described here allows quantitative determination of the abundance of volatile, semi-volatile, and non-volatile aqueous species in a single fluid sample. Elimination of the need to take separate major and gas-tight samples allows precious submersible time to be used for other activities and the reduced number of sampling devices permits other instrumentation to be carried in a submersible's limited basket space. The ability to carefully control the sampler fill rate minimizes seawater entrainment, making the new sampler ideally suited for collecting low temperature diffuse hydrothermal fluids.

Fig. 3. Plots of selected aqueous species versus Mg in hydrothermal fluids from the Main Endeavor vent field, northern Juan de Fuca Ridge, and bottom seawater (stars). The individual vent structure and date for each sample are as follows: Hulk 2000 (circles), Needle 2000 (squares), Bastille 1999 (diamonds), and Cantilever 1999 (triangles). See Butterfield et al. (1994) for a detailed discussion of this hydrothermal system. The solid symbols represent fluids collected with the gas-tight isobaric sampler presented here. The open symbols represent the extrapolated endmember composition of samples collected at the same time and locations in existing gas-tight samplers (Lilley, personal communication). The gray symbols represent the composition of fluids collected in "major" samplers. Only data for fluids collected in the new isobaric gas-tight samplers were regressed except for Cl and K, which included data for fluids collected in "major" samplers.

Acknowledgements

We thank the *Alvin* Group and officers and crew members of *Atlantis* for their dedication, skill, and enthusiasm. Helpful suggestions by the *Alvin* pilots played a major role during the development of the new gas-tight samplers. Careful reviews by Marv Lilley, Geoff Wheat and an anonymous reviewer are appreciated. Funds for this project were provided by NSF Grant OCE-9906752 and a Green Technology Award from WHOI. WHOI contribution no. 10510.

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Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66400**
For:	McLane Mooring Profiler
Type:	Official Quote
Date:	Sept 7, 2003 & July 22, 2005
Company:	McLane Research Labs
Requested By:	Tim McGinnis

Notes:

McLANE RESEARCH LABORATORIES, INC

Falmouth Technology Park
121 Bernard E. St. Jean Drive, East Falmouth, Massachusetts 02536 USA
Telephone: (508) 495-4000 • Fax: (508) 495-3333
E-Mail: mclane@mclanelabs.com

Date: September 7, 2003

To: **Lee Johnson, Buyer**
Tim McGinnis
Applied Physics Laboratory
University of Washington
1013 NE 40th St
Seattle, WA 98105
Tel: +1 (206) 543-1346
Fax: +1 (206) 543-6785/543 3854

From: Michael Mathewson
Subject: **Price Quotation #2004-MM-118**

Dear Lee:

As you have requested, I am pleased to provide the following updated price quote for MMP units and spares listed in RFQ AOM040217.

Part No.	Units	Description	Unit Cost
	1	McLane Moored Profiler (MMP) Extended (no sensors, no controller)	$ 35,080.00
	1	Spares: Extended Controller (Titanium) with TT8v2, Li battery	$ 16,710.00
FSI-ACM	1	Options: Falmouth Scientific Acoustic Current Meter	$ 9,975.00
FSI-CTD	1	Options: Falmouth Scientific Micro CTD	$ 9,980.00
SBE-41CP	1	Options: SeaBird 41CP CTD	$ 9,500.00
	1	Spares: MMP Electronics stack w/512MB Flash	$ 3,670.00
	1	Custom firmware modifications to communicate w/ APL controller	$ 4,000.00
	1	NRE to design motor for 1" (+/- 0.0625") diameter cable	$ 12,000.00
	1	Hull modifications to accommodate motor and cable	$ 3,500.00
	1	Spares: MMP Drive Motor w/Titanium housing and drive wheel for 1" (+/- 0.0625") diameter cable	$ 14,750.00
	1	Spares: MMP Toolkit	$ 95.00
	1	Spares: CTD/ACM Replacement Cable	$ 295.00
MMP-STOP	1	Spares: MMP Stoppers (set of 2)	$ 1,000.00
MMP-512FL	1	Spares: 512 MB Flash Card	$ 680.00
	1	Spares: Spring for drive motor	$ 56.00
	1	Options: Ballast MMP	$ 800.00
	1	Spares: Lithium Battery, 12.5 volt [240 mAh]	$ 2,400.00

Warranty: Three years on McLane parts and labor.
Prices: EXW East Falmouth, MA, USA.
Payment Terms: Net 30 days.
Delivery: 12 weeks ARO (After receipt of order)

As we discussed on the telephone, the MMP controller housing does have interior space available for an APL controller.

The MMP firmware includes the data unpacking software. Matlab based data analysis software is available from primary MMP users. There is no commercially available data analysis package from McLane.

The nominal speed of the MMP will remain at 25 cm/sec with the re-designed drive motor. Higher vertical speeds are not practical due to increased hydrodynamic drag and decreased battery endurance. The maximum cable diameter that can be specified is 1" (+/- 0.0625"). If desired, you may specify a smaller cable diameter with no change in price. The tolerance on the cable diameter (+/- 0.0625") will remain the same. In order to test the motor in our facility, we would need a 50 ft length (with eye terminations) of your chosen cable.

Please contact us if you have any further questions. We look forward to working with you.

Best Regards,

Michael Mathewson
General Manager

McLANE RESEARCH LABORATORIES, INC

Falmouth Technology Park
121 Bernard E. St. Jean Drive, East Falmouth, Massachusetts 02536 USA
Telephone: (508) 495-4000 • Fax: (508) 495-3333
E-Mail: mclane@mclanelabs.com

Date: July 22, 2005

To: **Lee Johnson, Buyer**
Tim McGinnis
Applied Physics Laboratory
University of Washington
1013 NE 40th St
Seattle, WA 98105
Tel: +1 (206) 543-1346
Fax: +1 (206) 543-6785/543 3854

From: Michael Mathewson
Subject: **Price Quotation #2005-MM-128**

Dear Lee (and Tim):

As you have requested, I am pleased to provide the following updated price quote for MMP modifications and spares listed in ALOHA/MARS MMP specification v1.6 and RFQ AOM0506061.

Item No.	Units	Description	Unit Cost
1	1	MMP Firmware modification (10 commands, 2 DIO lines)	$ 12,000.00
2	1	3rd Sphere option for rechargeable batteries (including connectors and testing) and to increase MMP buoyancy	$ 12,123.00
3, 4, 5, 6, 8	1	Extended Ti controller housing with endcaps, connectors, cables, chassis	$ 13,724.00
7	1	Mount SBE Inductive Coil in MMP front panel	$ 925.00
	1	Ballast Measurement in McLane Test Tank	$ 850.00
	1	McLane Test Tank with Engineer (daily rate)	$ 800.00
	1	Engineering (hourly rate)	$ 100.00

Warranty: Three years on McLane parts and labor.
Prices: EXW East Falmouth, MA, USA.
Payment Terms: Net 30 days.
Delivery: 12 weeks ARO (After receipt of order)

Please contact us if you have any further questions. We look forward to working with you.

Best Regards,

Michael Mathewson
General Manager

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66401**
For:	Acoustic Releases
Type:	Official Quote
Date:	March 16, 2011
Company:	IXSEA
Requested By:	Tim McGinnis

Notes:

University of Washington

Seattle, WA, USA

COMMERCIAL OFFER

QU_1103_02145

Dated 16-Mar-11

1. Reference of the enquiry

Contact at IXSEA:

Edward J. Cheesman
Regional Sales Manager

1774 W Sam Houston Parkway N
Houston,Tx,77043
USA

Tel:	+1 713 338 2472
Cell:	+1 281 633 6667
Email:	ed.cheesman@ixblue.com
Website:	www.ixblue.com

Client Contact Detail:

Tim McGinnis
Email: tmcginnis@apl.washington.edu

Project goals and history:

Requirement for: 2 x OCEANO 5000 this year and 1 x TT801 deck box and a further 4 x OCEANO 5000 + 1 TT801 next year.

2. Commercial details

2.1. OCEANO acoustic releases range

Prices below are net in US $, exclusive of VAT, freight, insurance, import taxes, customs fees or other duties.

OCEANO 5000 Acoustic Release
Construction: UNS32550 Super Duplex Stainless Steel
Depth rating : 6,000m
Load characteristics: SWL 5,000 kg / RL 5,000 kg / TL 10,000 kg
Weight in air/water: 40 kg / 31 kg
Release ring not included
Alkaline batteries (Lithium an option per below)
Supplied with user manual, tools kit in wooden transit box

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OIAR861DS	OCEANO 5000	$17,790	2	$35,580

2.1.1. OCEANO Acoustic Telecommand Unit and transducer

Note:
OCEANO Acoustic Telecommand units are compatible with the full OCEANO acoustic release range. Standard configuration includes the surface telecommand unit itself and its dunking transducer, with optional transducers designed for harsh/difficult operating conditions.
Please refer to dedicated OCEANO range technical description or to your nearest IXSEA office or distributor.

TT801 Acoustic Telecommand and dunking transducer
- Universal surface telecommand for all IXSEA acoustic release / transponder range
- Sends command and receive acknowledgement
- Rugged plastic box
- Internal rechargeable batteries and external power supply
- Supplied in light wooden box with cords, headset and user manual

Dunking Transducer
- Plastic body dunking transducer model PET801P or PET661-TT rugged transducer
- 15 m or 30m electric cable

(TT801 and 30m long transducer shown on left)

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OITT801	TT801 Telecommand	$13,000	0	0
OITT801-15P	TT801 & 15m long cable dunking transducer	$15,000	1	$15,000
OITT801-30P	TT801 & 30m long cable dunking transducer	$15,850	0	0
OITT801-30R	TT801 & rugged transducer (30m electro-mechanical cable)	$17,500	0	0

SUB TOTAL main equipment	$50,580

Options & Accessories

Non exhaustive list.
Please refer to dedicated OCEANO range technical description or to your nearest IXSEA office or distributor.

2.1.2. OCEANO range recommended release rings

5,000 kg SWL release ring
- UNS32550 Super Duplex Stainless Steel
- Compatible with OCEANO 2500 Universal and OCEANO 5000
- Section 25mm, 90 x 155mm internal

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
A910 3235-TR	5,000kg SWL release ring	$ 420	2	$ 840

2.1.3. Options for OCEANO acoustic Releases

Remote Head Option for AR/RT/ET8x1 series
NOTE: price valid for new instrument delivery only
- Remote transducer head for AR8xx series
- Comprises:
  - Remote LF head and protective cage
  - 3m long cable (9300136) on SUBCONN plugs
- Modified upper AR8xx end plate

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OIUPGR-S-HD-3m	Remote Head Option for OCEANO 2500/5000 AR's	$ 3,185	0	$ 0

Lithium Battery pack for AR/RT/ET8xx and 9xx series
- Lithium battery stick option for extended autonomy

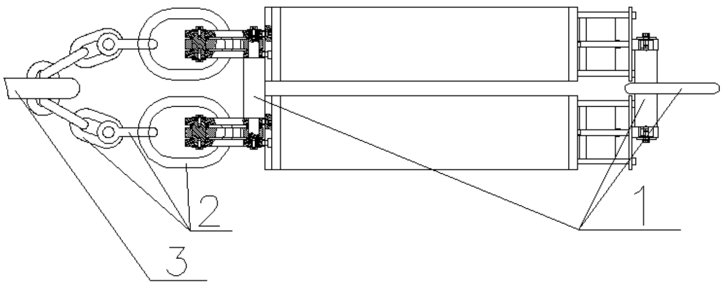
Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
BT0004-LI	Lithium Battery pack	$ 900	1	$ 900

2.1.4. Tandem mounting kit for OCEANO AR's

The OCEANO AR's Tamdem mounting kit allows coupling of two identical Acoustic Releases in the OCEANO range to be installed in parallel for increased mooring load capacity and full redundancy of the mooring function.
The kit comprises of:

- (ref1) 2 off Spacers, screws, washers and the upper lifting ring
- (ref2) 1 off Dual rings assembly with chain and shackles
- (ref3) off wide consumable circular release ring

Consumable / spare parts list is provided



Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OITandem-DS	OCEANO 5000 series coupling kit	$ 5,240	0	$ 0

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
A R345300B	10t SWL wide diameter ring for OCEANO 5000	$ 650	0	€ 0

2.1.5. Optional transducers for Acoustic Telecommand Units

Standard option 1 Option 2

	standard	Option 1	Option 2
content	PET301P & 15/30m long cable	Rugged transducer + electromechanical cable	AM661S acoustic module & 100m electromechanical cable
advantage	Lightweight, Low cost	Heavier (sinks better)	Better SNR 100m (max) from surface
application	Standard conditions Shallow water Small ship	Standard conditions Shallow water High current Ship moving	Noisy environment Deeper water

Dunking transducer and cable

- Plastic body dunking transducer model PET801P
- 15 m or 30m electric cable
- TT801 / TT701 compatible

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OIPET801-15P	**Plastic dunking transducer & 15m long cable**	**2,150**	**0**	**0**
OIPET801-30P	**Plastic dunking transducer & 30m long cable**	**2,850**	**0**	**0**

Rugged dunking transducer & electromechanical cable

- Super Duplex stainless steel construction
- 30m electromechanical cable (breaking strength 200kg)
- SUBCONN mating socket + dummy plug and locking sleeves
- Cable grip / 2 x shackles at each end
- TT801 / TT701 compatible

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OIPET661S-TT	**Rugged dunking transducer**	**$ 3,750**	**0**	**0**
930-0117	**30m long electromechanical cable for OIPET661S-TT**	**$ 2,015**	**0**	**0**

AM661S Acoustic module

- Active transducer compatible with TT801 telecommand system
- Super Duplex stainless steel construction
- Size/weight: 600mm long x 130mm diam.
- Shipped in GRP transit box

100m long electromechanical cable on cable reel

- 100m electromechanical cable (breaking strength 200kg)
- SUBCONN mating socket + dummy plug and locking sleeves
- Cable grip / 2 x shackles at each end
- Lightweight paint protected portable cable reel
- Shipped in tri-wall carton box

Ordering code	Product description	Unit price ($)	Qty.	Total price ($)
OIAM661S	**AM661S Acoustic Module**	**$ 10,275**	**0**	**0**
930-0102	**100m long electromechanical cable for AM661S**	**$ 5,560**	**0**	**0**
	SUB TOTAL Options & Accessories			**$ 1,740**

Product Services

Ordering code	description	Unit price ($)	Qty.	Total price ($)
ADOFFSHOREDRATE	**IXSEA Offshore Field Engineer day rate** Flight, accommodation & subsistence at cost+10% if paid by IXSEA	**$ 1200**	**0**	**$ 0**

Ordering code	description	Unit price ($)	Qty.	Total price ($)
ADONSHOREDRATE	**IXSEA Onshore Field Engineer day rate** Flight, accommodation & subsistence at cost+10% if paid by IXSEA.	**$1200**	**0**	**$ 0**

Ordering code	description	Unit price ($)	Qty	Total price ($)
ADFORMTINE	**Training day rate** Flight, accommodation & subsistence at cost+10% if paid by IXSEA.	**€ 1,500**	**0**	**$ 0**

SUB TOTAL product services	**0**
GRAND TOTAL commercial offer	**$52,320**

3. Quality management

IXSEA has been engaged for several years in a quality process to maximize the satisfaction of its customers. IXSEA is certified ISO9001 by Bureau Veritas certification in the main manufacturing plants at Marly-le-Roi and Brest, France.

The quality manual is available on our web site www.ixsea.com

4. Terms and conditions

The standard IXSEA terms and conditions apply as set in the following page and in particular:

Price:
Prices are ex-works Brest – FRANCE, net in US $, exclusive of VAT, freight, insurance, import taxes, custom fee or other duties.

Delivery time:
Standard delivery terms for the product is: 6-12 weeks
Whenever an export, import or transfer license is required for the goods that are ordered IXSEA may decide not to deliver the goods before receiving the licenses required.

Shipment:
Ex-Works Brest – France factory according to INCOTERMS 2000.
Shipment expenses will be charged back to customer at cost +15%, if paid by IXSEA

Terms of Payment:
100% at 30 days net upon presentation of Commercial Invoice or by Irrevocable and Confirmed Letter of Credit to be opened for 100% of contract and payable upon presentation of the shipping documents.

Bank Details:

Please remit payment to:	or wire payment instructions as follows:
IXSEA, Inc 179 Sidney Street, Cambridge, MA 02139, USA Tel : 781 937 8800 Fax : 781 937 8806	CITIZENS BANK 6, JFK St Cambridge MA 02318 , USA ACCOUNT Nb: 1306482752 ABA # 011500120 Swift Code: CTZIUS33

Warranty:
1 year including parts and labour
IXSEA product is guaranteed to be free from defect in material and workmanship over the warranty period, from date of shipment. During the warranty period, IXSEA will repair or replace, at its own option, the defective parts if any. Defective products shall be returned to IXSEA under owner's responsibility and expenses.

Limits of warranty:
The guarantee will be considered **void if the unit has been opened.**

Validity of the offer:
90 days based on date of this offer.

GENERAL TERMS OF SALE AND CONDITIONS

Article 1 – Approval of the General Terms of Sale

By issuing an order to IXSEA, the Purchaser accepts and undertakes to comply voluntarily with these General Terms of Sale that have been communicated to the Purchaser and that shall prevail over any Terms of Purchase, unless this provision is waived formally and expressly by IXSEA.

Article 2 – Confidentiality

2.1. The Purchaser undertakes, both personally and on behalf of any person under the Purchaser's authority (including the Purchaser's staff, partners, joint contractors, subcontractors, etc.), to take all measures deemed necessary, as required to comply with the industrial property rights (patents, drawings, designs, etc.) of IXSEA or of any other person involved in the manufacturing of the goods, and to have such rights complied with, and to keep as secret all the technical documents, studies, information and know-how associated with patents, drawings, designs, etc., as will be communicated to the Purchaser by IXSEA and to which the Purchaser or any other person may have access in order to be able to use the goods sold.
2.2. All studies, schemes, drawings and other documents provided or sent by IXSEA shall remain the property of IXSEA and they may not be disclosed to any third parties by the Purchaser for any reason whatsoever without the prior written authorization of IXSEA.

Article 3 – Formation of the Sales Contract

3.1. Orders received from the Purchaser will only be deemed accepted definitively once confirmed in writing by IXSEA. Such acceptance shall be the sole instrument valid to determine the Special Terms of the order, if any.
3.2. Whenever a quotation is established by IXSEA at the Purchaser's request, Special Terms that would modify or supplement these General Terms of Sale may only be added once the order has been confirmed by IXSEA.
3.3. The terms set out in the quotations issued by IXSEA shall be valid for a period of ninety (90) days, starting from the date they are established.

Article 4 – Deliveries – Transportation of the goods

4.1. Conditions
Unless otherwise specified, the goods shall be deemed delivered to the Purchaser at the IXSEA plants or stores upon notification of availability to the Purchaser, or upon remittal to a forwarder or a carrier designated by the Purchaser to IXSEA. The Purchaser shall take delivery of the goods within fifteen days of the notification of availability. Upon expiration of this time period, the Seller shall be entitled to consider that the order has been cancelled unilaterally and automatically by the Purchaser without prior formal notice.
4.2. Delivery periods
Deliveries shall be made according to the availability of goods, and in the order of reception of the orders. The delivery periods shall be stated in IXSEA's acceptance of the order. Should any deliveries be delayed for any reason beyond the Seller's control, the Purchaser may not demand that the contract be cancelled, or claim for indemnification for any damage sustained. Delays with respect to the delivery periods shall not give rise to any damages, countercharge, or cancellation of orders whether confirmed or in process. The Seller may make partial or total deliveries.
4.3. Transportation costs and risks
Unless otherwise specified, the Purchaser shall bear all costs and risks associated with the transportation of the goods sold, and any other expenses incurred, if any.

Article 5 – Export and import licenses for the goods

Whenever an export, import or transfer license is required for the goods that are ordered IXSEA may decide not to deliver the goods before receiving the licenses required.

Article 6 – Authorization to re-sell the goods

The Purchaser is the end user of the goods, in the Purchaser's normal course of business. The Purchaser may ask the prior authorization, and be authorized in writing by IXSEA, to re-sell the goods delivered. The Purchaser may not pledge the goods delivered or use them as security, or transfer the title thereto, even as a guarantee, without the prior written agreement of IXSEA.

Article 7- Authorization to transform the goods

The Purchaser is not authorized, in the Purchaser's normal course of business, to transform the goods.

Article 8 – Price of the goods

8.1. Pricing
All prices stated are prices before tax and are based on IXSEA tariffs in US $, as communicated to the Purchaser. The goods are invoiced at the current prices mentioned in the confirmation of the order. Any taxes, charges or duties payable under French law or under any foreign law (import or transit country, etc.) shall be borne by the Purchaser. Unless otherwise specified, the packaging, transportation, insurance and other costs shall always be borne by the Purchaser.
8.2. Terms of payment
The price shall be invoiced to the Purchaser when the goods are:
delivered at the plant and payable cash; or
remitted to the carrier, and shall be paid by bank transfer on the date, and according to the bank details mentioned in IXSEA's confirmation of the order.
8.3. Sanctions and penalties applicable in case of non-payment or late payment
In case of late payment, or non-payment on any agreed maturity dates, IXSEA shall have the right to suspend the execution of the confirmed orders in process, without prejudice to any other right or action that IXSEA may use or take in order to obtain the cancellation of the confirmed orders and/or damages. Also, as a penalty clause and without prior notice, the Purchaser shall be liable *ipso jure* for a penalty for late payment or

non-payment, to be calculated according to the whole of the sums payable, by application of an interest rate equal to one and a half % in addition to the legal interest rate in force in France on the date of default of payment on the due date. In case of non-payment on the due date, the Seller may decide to cancel the sale for good reason, without prior notice and the Seller may ask in emergency proceedings that the goods be returned, without prejudice to any other claims for damages. The Seller may also decide to cancel for good reason and without prior notice confirmed orders in process and any prior orders, whether already delivered or in the delivery process, and for which payment is due

Article 9 – Retention of title to the goods

The Seller shall keep title to the goods sold until the price has been paid in full, including the principal, and any applicable interests and penalties. For the purpose of this clause, the remittal of an instrument giving rise to an obligation to pay (bill of exchange, or any other mode of payment) shall not be held as effective payment.. Any failure to pay any sums payable by a due date shall entitle the Seller to claim for the goods. In case of a seizure, or in case of intervention of a third party, the Purchaser shall notify IXSEA immediately and shall inform the said third party of the retention of title by IXSEA. The above provisions shall not preclude the transfer to the Purchaser, upon delivery, of the risks of loss and damage to the goods sold, and the risks of damage that the goods may cause.

Article 10– Return of the goods

Without prejudice to any claims against the carrier, all claims for apparent defects on, or non-conformity of the goods delivered shall be notified not later than thirty days after the ex-works delivery. The Purchaser shall provide the Seller with all evidence in proof of the anomalies detected. The Purchaser shall fully allow the Seller to remedy such anomalies and shall refrain from intervening himself or having any third party intervene for that matter. Any return of goods shall be agreed upon in a written agreement between the Seller and the Purchaser, and all costs and risks associated with the return of the goods shall be borne by the Purchaser. Should any apparent defect or non-conformity be observed on the goods delivered and duly ascertained by the Seller, the Purchaser may request to have the goods replaced at no extra cost, or reimbursed, without any other indemnification.

Article 11 – Seller's contractual warranty

11.1. Terms of the contractual warranty

The goods sold are guaranteed against any such operating defects as may result from defective material, workmanship, design or assembly, as set out below. The operating defect must be detected during the period of twelve months following delivery, and during normal use and for the intended purpose of the goods. Warranty is excluded in the following cases:

- if the component used, or the defective design of the goods is attributable to specific requirements of the Purchaser;
- if the operating defect was caused by an intervention on the product or as a result of a transformation that was performed without the Seller's prior approval;
- if the operating defect was caused by abnormal use and/or use without complying with the intended function of the goods;
- if the failure was caused by normal deterioration of the product, or by negligence or by improper maintenance on the part of the Purchaser;
- if the failure was caused by force majeure.

11.2. Enforcement of the contractual warranty

As part of the warranty, the Seller shall decide whether to repair or replace the goods and/or any parts recognized as defective by his own technical experts, at no extra costs. This warranty shall cover the labor costs of the following operations: disassembly, reassembly, at the Seller's plant. The replacement of parts shall not cause the warranty period mentioned in Article 11.1 above to be extended.

11.3. Limitation of the contractual warranty

It is expressly agreed between the parties that the Seller's liability in case of an operating defect on the goods shall be limited to the above provisions, and in case of damage shall give right to payment of an indemnity in an amount equal to the price of the goods.

Article 12– Automatic cancellation

Should the Purchaser fail to fulfill one of his obligations, the contract may be cancelled for good reason, at the Seller's request, without prejudice to any damages that may be claimed against the Purchaser in default. Except for the special provisions of Article 8.3. above, cancellation shall take effect automatically fifteen (15) days after a formal notice has been sent and has remained without effect.

Article 13 – Cancellation of a clause

Should any provisions of these General Terms of Sale be cancelled or made void, such cancellation or void ness shall not affect the other provisions herein or the validity of the General Terms of Sale as a whole.

Article 14 – Settlement of disputes

Any dispute arising in connection with a sale and that cannot be settled by amicable arrangement shall be finally settled by the commercial court having sole jurisdiction in the Seller's registered office

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66402**
For:	Underwater Slip Ring Assembly
Type:	Official Quote
Date:	July 15, 2010
Company:	Moog Focal
Requested By:	Tim McGinnis

Notes:

MOOG
COMPONENTS GROUP

Quotation

When placing order please clearly state MCG Quote and Part Number

Moog Inc., Components Group
Halifax Operations
Focal Technologies Corp.
77 Frazee Avenue
Dartmouth, Nova Scotia, Canada
B3B 1Z4
Tel: 902-468-2263
Fax: (902) 468-2249
Email: focal@moog.com
Homepage: www.moog.com/marine

FOCAL™

Quote Number	Q-08088-B0FS Rev 0	**Customer Id**	BP0000529
Date Created	15 Jul 2010	**Subject**	Model 180 - Titanium Housing
Quotation Valid	15 Jul 2010 - 13 Sep 2010		

To: **Applied Physics Lab**
1013 NE 40th Street
Seattle, Washington 98105 United States

Tim McGinnis

Tel: (206) 543-1346

Email: tmcginnis@apl.washington.edu

Line	Product	Description	Qty	Unit Price	Extended Price
1	Model 180	Electrical Slip Ring assembly configured as per drawing 180-2540-00. Unit is fitted with oil-filled fittings and is suitable for oil-filling by others. All external parts are manufactured with 304 Stainless.	1	6,600.00	6,600.00
	DELIVERY: 10 Weeks ARO				
2	Model 180	Electrical Slip Ring assembly configured as per drawing 180-2540-01. Unit is fitted with oil-filled fittings and is suitable for oil-filling by others. All external parts are manufactured with Titanium.	1	12,988.00	12,988.00
	DELIVERY: 12 Weeks ARO				

Focal Terms & Conditions Document Rev R (12-11-07) apply.

Currency : US Dollar

Ex Works Origin

Payment Terms TBD

Remit to: Focal Technologies Corporation
77 Frazee Avenue
Dartmouth, Nova Scotia, Canada
B3B 1Z4
Tel:(902) 468-2263
Fax: (902) 468-2249
Email : focal@moog.com
Homepage: www.moog.com/marine

Jeff Coles - Technical Sales Support

Tel : (902) 468-2263 x5434

Email : jcoles@moog.com

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66403**
For:	Mobile Pressure Recorder
Type:	Email
Date:	3/14/2011
Company:	Parros Scientific with integration (OSU/MBARI/LDEO)
Requested By:	GP, Orest

Notes:
Dual mobile pressure recorder for verification of PREST, BOTPT

> From: Scott Nooner <snooner@ldeo.columbia.edu>
> Date: March 14, 2011 9:08:10 AM PDT
> To: "Kawka, Orest E." <kawkaoe@uw.edu>
> Subject: Re: MPR in situ verification/calibration
>
> Hi Orest,
>
> I'm in Bangladesh right now, so I can't give you a very precise
> estimate, but I can tell you that the Paroscientific 410K gauges
> that we use are about $4500 each. A pressure case might be another
> $5000-$10000, and the electronics are probably another $10,000. So
> I'd say it would be somewhere in the ballpark of $25-30K to make
> another MPR package. Calibrating the gauges every two years is
> probably enough and would cost $2-4K each time, I think.
>
> Cheers,
> Scott
>
> On Mar 14, 2011, at 11:29 AM, Kawka, Orest E. wrote:
>
>> Hi Scott,
>>
>> Thanks for the response. Could you give me a very rough estimate
>> on the cost to build such an MPR and then have it calibrated
>> annually?
>>
>> Cheers,
>> Orest
>>
>> Orest E. Kawka, PhD
>> Project Scientist
>> Regional Scale Nodes Program
>> Ocean Observatories Initiative
>>
>> Email: kawkaoe@uw.edu
>> Office: 206-221-6411
>> Fax: 206-221-6771
>> Mobile: 206-660-9822
>>
>> On Mar 14, 2011, at 4:08 AM, Scott Nooner wrote:
>>
>>> Hi Orest, Bill and Chris,
>>> I've made a few comments below:
>>>
>>> On Mar 13, 2011, at 8:04 PM, Bill Chadwick wrote:
>>>
>>>> Orest -
>>>> I'm going to cc my colleague Scott Nooner so that he can
>>>> comment if he wants or correct anything I might mis-state (he
>>>> knows more about the MPR data processing than I do).
>>>>
>>>>> Hi Bill and Chris,
>>>>>
>>>>> Couple of quick questions regarding O&M.
>>>>>

>>>>> 1) HYPOTHETICALLY, if we were to deploy 3 BPR/Tilt instruments
>>>>> on Axial and were to visit them once a year would you recommend
>>>>> a "dual" transducer MPR system attached to an ROV, as described
>>>>> in the 2006 paper, as the best means to calibrate (correct for
>>>>> drift) of the deployed BPRs? Is there a simpler method that you
>>>>> would feel comfortable with?
>>>>
>>>> The "dual transducer MPR" just means that we have two Paros
>>>> pressure gauges in one pressure housing. Two is better than
>>>> one, because it guards against one of the gauges malfunctioning,
>>>> and if they both work then it's like making twice as many
>>>> measurements, so it gives you better statistics for reducing the
>>>> error of the measurements.
>>>
>>> Right now this is the only way to correct the BPRs for drift.
>>> Mark Zumberge at Scripps is working on a self calibrating
>>> pressure gauge but it will be several years until that system is
>>> complete and reliable.
>>>
>>>>>
>>>>> 2) Is the MPR something that is still currently functional? If
>>>>> it is, would that be something that could be "borrowed" for
>>>>> annual maintenance cruises?
>>>>
>>>> Yes, in fact we'll be using it at Axial this summer in late July
>>>> to re-do our inflation measurements. We also submitting an NSF
>>>> proposal last month to keep doing these measurements in 2013,
>>>> 2015, and 2017. We'll know if that got funded in July. We MPR
>>>> we use is owned by Mark Zumberge at Scripps. I would think you
>>>> would want Scott involved in the MPR measurements or at least
>>>> the data processing to make sure it's all being done
>>>> consistently with what we've done in the past, etc.
>>>
>>> As far as borrowing the MPR, it would probably be possible, but
>>> it might be better to build another one so that there would be no
>>> conflict with usage for other projects. It would be relatively
>>> inexpensive to construct another one at Scripps I think. Be aware
>>> that the procedure for making measurements is critical to the
>>> success of this technique. Mark Zumberge, Bill and I have worked
>>> hard to figure this out.
>>>
>>>>>
>>>>> As a sidenote - I am curious. Do you somehow "calibrate" the
>>>>> MPR before using it, or is it really just a way to correct for
>>>>> relative drift amongst benchmarks or deployed BPRs?
>>>>> Perhaps I missed that part in the papers.
>>>>
>>>> Yes, I think the MPR is calibrated each year before we take it
>>>> to sea because we are interested in the relative *depths*
>>>> between our benchmarks, so a pressure calibration is important.
>>>> Scott should probably comment on this.
>>>
>>> We do calibrate the pressure gauge with a dead weight calibration
>>> system at Scripps. There is a slow DC shift in the absolute
>>> pressure (caused by gauge drift) but very little if any change in
>>> the scale factor of the gauges (how a real change in pressure
>>> maps into a measured change in pressure). This scale factor is

>>> the most important thing for us since we are making relative
>>> depth measurements, so the gauges have been very stable for us.
>>>
>>> Cheers,
>>> Scott
>>>
>>>
>>>> -Bill
>>>>>
>>>>> Orest
>>>>>
>>>>> Orest E. Kawka
>>>>> Project Scientist
>>>>> Regional Scale Nodes Program
>>>>> Ocean Observatories Initiative
>>>>>
>>>>> Email: kawkaoe@uw.edu
>>>>> Office: 206-221-6411
>>>>> Fax: 206-221-6771
>>>>>
>>>
>>> ~~~~~~
>>> Scott Nooner
>>> Palisades Geophysical Institute Assistant Research Professor
>>> Lamont-Doherty Earth Observatory
>>> Columbia University
>>> Oceanography 303C
>>> 61 Route 9W
>>> Palisades, NY 10964
>>> phone: 845-365-8944
>>> fax: 845-365-8179
>>> snooner@ldeo.columbia.edu
>>> ~~~~~~
>>>
>
> ~~~~~~
> Scott Nooner
> Palisades Geophysical Institute Assistant Research Professor
> Lamont-Doherty Earth Observatory
> Columbia University
> Oceanography 303C
> 61 Route 9W
> Palisades, NY 10964
> phone: 845-365-8944
> fax: 845-365-8179
> snooner@ldeo.columbia.edu
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Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66404**
For:	ROV Jason 2010 RSN Enlighten'10 Field Program
Type:	Official Quote
Date:	June 1, 2010
Company:	Wood Hole Oceanographic Institution
Requested By:	John Delaney

Notes:
Enlighten cruise was onboard the R/V Thompson July 26- August
22 to conduct detailed site surveys for deployment of secondary

Proposal to the

University of Washington
School of Oceanography
By

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

DUNS No. 00-176-6682 IRS #04-2105850

Revision
Enlighten 2010 (Jason Use)

Requested Start Date:	June 1, 2010
Requested Duration:	7 Months
Estimated Costs	$ 690,235

Endorsements:

Principal Investigator:

Andrew D. Bowen
Director NDSF
Phone: 508-289-2643
Fax: 508-457-2191
email: abowen@whoi.edu

Claire L. Reid
Director of Grant and Contract Services
Phone: 508-289-2462
Fax: 508-457-2189
email: creid@whoi.edu

Robert S.C. Munier
Vice President for Marine Facilities & Operations
Phone: 508-289-3335
Email: rmunier@whoi.edu

Date: July 02, 2010

STATEMENT OF WORK

The National Deep Submergence Facility will provide and operate the ROV Jason in support of the scientific objectives of the R/V THOMPSON cruise scheduled to depart Seattle, WA on or about July 24, 2010. Leg One of the cruise will be at Hydrate Ridge on the Oregon Margin during which time Sentry (Sentry Use on separate UW proposal #14922.01) and Jason each will be deployed at depths ranging from 80 to 3000 meters. With both vehicles operating, Jason would generally use USBL and Sentry would utilize LBL transponders as required. Following a brief port call in Newport, OR to exchange personnel, Jason will resume mapping, sampling and photomosaicing Leg Two at Axial Volcano about 200 miles off the Washington Coast. We expect to conduct concurrent operations with Sentry during phase 1 at Hydrate Ridge. The operations scenario will be for both vehicles to deploy on a daily basis, overlapping their time in the water by several hours allowing for greater than 24 hours of total vehicle in water time per day.

JASON

The ROV Jason will be equipped with its standard sensor suite as listed on the NDSF web site. In addition the vehicle has been upgraded in several ways. We have added a Schilling Titan 4, 7-function manipulator to augment the standard Kraft Predator, 7-function manipulator, a Reson multibeam sonar, HDTV and USBL navigation. Additionally we've increased our analog video from 8 to 16 channels providing the ability for several simultaneous YC format feeds, and increased the bandwidth of our ethernet link allowing Jason to support multiple ethernet sensors at one time.

During Leg 1, while Sentry is mapping, Jason will conduct real-time imaging and sampling at the proposed sites for Ocean Observatories uncabled moorings. A second site during this leg, Hydrate Ridge, is a large methane hydrate deposit. Sentry and Jason will be mapping and sampling extensively at this site in support of cable, mooring, and sensor installations. Underwater photos and high definition imagery are an important aspect of the Jason data to be collected.

Bathymetry data will be provided in raw (*.s7k) files as well as in grids that are produced using NDSF's semi-automated tools. These grids will be produced using the NSF-supported tool called MB-system, and can be subsequently ingested into a variety of packages such as Caris, Fledermaus, and Generic Mapping Tools. The semi-automated tools post-process the navigation, reconciling the dead reckoning track with available external references (USBL), removing most "flyers" and providing absolute RMS errors of typically 10 meters. The creation of accurate high-resolution maps ($\leq$ 5 m resolution) requires additional data processing that addresses the small navigational uncertainties associated with underwater vehicle navigation. Refined bathymetry data products can be generated post-cruise by NDSF personnel on a cost reimbursable basis.

Capture position of photographs that will comprise a photomosaic can be inferred from navigation data through photograph time-of-capture. The photomosaic system provided by Jason records image files that are named according to capture time of the image. If position for images captured by the client's video system is desired, these images must be annotated by time information in some form. Matching of image capture time to Jason navigation data is not performed by the Jason data processor."

Following a brief port call in Newport, OR for a personnel change, Jason will resume operations for Leg 2. Working about 400 km off the Washington coast, Jason will produce high resolution maps and photomosaics of Axial Seamount. Researchers will use this data to “plan out cable routes and instrument deployment sits”. Jason intends to use the USBL navigation system.

DAY RATE

The “Day Rate” for the ROV ($19,997/day) covers all costs associated with the preparation, transportation to & from the University of Washington and the at-sea operation of the vehicles. The operational personnel’s support and travel is included. A total of 33 charge days would be associated with the ROV consisting of 29 at-sea days plus 2 mobilization and 2 demobilization days. Also included are costs for use of the Scripps Dynacon Winch and travel costs associated with the technician who will load the winch onto the R/V Thompson. There are no costs associated with the transportation of the winch to and from R/V Thompson.

Total cost estimate:

33 days ROV Jason at $19,997 per day	=	$659,901
Dynacon Winch at $872 per day	=	$28,776
Travel for technician to load winch	=	$1,558
Freight for winch	=	N/C

Proposal total cost = $690,235
Terms and Conditions

(The work proposed is being submitted on a best effort basis.)

PROVISIONAL RATE TERMS

The rates shown in the budget for submersible costs are projected and provisional because WHOI operates the submersibles as cost centers and allocates the costs to user projects at a provisional rate subject to adjustment to the actual rate at the end of the calendar year. The final daily rate is derived from the total costs divided by the operating days during the 12-month calendar year period.

An *operating day* is a calendar day when the submersible vehicles are working incident to the scientific mission. Operating days can be at sea or in port during mobilization and demobilization. The number of mobilization and demobilization days can vary from cruise to cruise and should be discussed with the asset manager. A fraction of a day is a whole day.

The number of *operating days* to be charged to each agency for a cruise funded by multiple funding sources is based on a percentage of the number of dives per agency to the total number of *operating days*. The number of dives for an individual agency is divided by the total number of dives to determine a percentage of total operating days to be allocated to the individual agencies. The resulting percentage is then multiplied by the total charge days to determine the breakdown of days to be charged.

Potential Rate Increase: Should WHOI's income derived from the supporting projects be less than that estimated for establishing the projected rates, and/or the costs of operating the submersibles groups during the calendar year are increased thereby increasing the projected rates, WHOI shall be compensated at the end of the calendar year for the increased rates. However, any increase shall not exceed fifteen percent (15%) of the per diem rate quoted as the provisional rate. WHOI shall invoice for any increased rate adjustment within three (3) months after the end of the calendar year.

Potential Rate Decrease: Should WHOI's income derived from the supporting projects be greater than that estimated for establishing the projected rates, and/or the costs of operating the submersibles groups during the calendar year are less than estimated in establishing the daily rate, thereby decreasing the projected rates, WHOI shall reimburse for the decreased rate. Reimbursement by WHOI of the accrual of reduced rates shall be made within three (3) months after the end of the calendar year.

Best Effort Clause: Operation of the NDSF assets is done on a best effort basis. Lost scientific station time **at sea** due to weather, scientific equipment failure, ship's equipment failures, or other NDSF system failures, are chargeable days and will not affect the number of charge days agreed to prior to the beginning of the operation

Any exception to these terms must be approved by the Vice President for Marine Facilities and Operations.

Basis for Calculating Billable Costs: Upon completion of the cruise WHOI will invoice The University of Washington's School of Oceanography for the cost of the cruise using the above provisional rate terms. The full amount will be due standard net 30 days of the invoice date. The University of Washington's School of Oceanography will be informed of any adjustments for rate increase or decrease, as explained above, when the financial reports for CY2010 are closed at WHOI.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-00001**
For:	ROV ROPOS 2011 RSN Cruise
Type:	Official Quote
Date:	January 31, 2011
Company:	Canadian Scientific Submersible Facility
Requested By:	Debbie Kelley

Notes:
This quote is for site verification, and to complete final survey
Routes for extension cables on the RSN VISIONS'11 cruise
using the R/V Thompson August 11-September 1, 2011.
Field work will include site verification at Southern Hydrate Ridge
and Axial Seamount.

CANADIAN SCIENTIFIC
SUBMERSIBLE FACILITY
ETABLISSEMENT CANADIEN DES
SUBMERSIBLES SCIENTIFIQUES

110 - 9865 West Saanich Road
North Saanich B.C. V8L 5Y8
Canada
tel: (250) 655-5096
fax: (250) 655-5097
email: shepherd@ropos.com

Promoting undersea research
with Canadian technology

January 31, 2011

To: Deborah Kelley, University of Washington

Re: ROPOS charter for 2011

Thank you for your inquiry for use of the ROPOS system in 2011. Listed below are our rates for 24 hour per day operations in our mid-depth mode.

Mobilisation/demobilisation cost is quoted for loading onto the Thomas G Thompson. This must be at the Esquimalt Graving dock. Our costs will be higher if we need to mobilize in a different location or facility.

You will need to allow 48 hours for us to mobilise on the vessel, and 12 hours for us to demobilise. Please allow for the additional ship time for this work.

Mobilisation/demobilisation, mid-depth system, maximum depth 3000 metres:
Lump sum $107,400. This includes the mobilisation of the navigation equipment. (see note on sharing below)

ROPOS system, 24 hour per day operations, mid-depth system
CAD$25,702/day (discounted to US$21,850/day)

ROPOS USBL navigation system
CAD$2128/day (US$2128/day)

Discount:
A 15% discount is applied to the ROPOS system day rate in the interest of fostering a long term partnership with the Regional Scale Nodes (RSN) group at the University of Washington.

Total day rate:
US$23,978/day

Terms:
Mobilisation costs and 30% of operational total must be received in advance to reserve the time.
Balance due upon completion of mission.

Note:
Mobilisation sharing: It is anticipated that we will be mobilised onto the vessel Thomas G Thompson for NEPTUNE Canada work before and after the UW RSN work. If this transpires, it would make sense to share the mobilisation costs between the two parties on some prorated basis. There would be some costs associated with leaving the system on board, as we would still need to perform maintenance. Details of this can be discussed as the schedule and work plan is developed.

Please don’t hesitate to contact us if you have any comments or questions.

Regards,

Keith Shepherd, General Manager

INCLUDED EQUIPMENT:

Vehicle:

- Work class ROV
- 40 horsepower or greater power
- 300 lb lift capacity(free flying)

Imaging:

- 1 x wide angle (90 degree or greater diagonal field of view), 3 CCD, 10 x zoom, 1080p HD Camera on pan/tilt unit
- 1 x HD camera on Tilt unit
- 2 additional composite video cameras mounted as directed by client
- 1 x 12 Mpixel digital still camera, with real time video framing, on tilt unit
- 2 kW lighting, LED, HID and HMI acceptable
- 4 x Parallel 532 nm lasers; mounted on both colour HD cameras
- 1 x Simrad MS1000 Sonar
- Video stream must provide selectable overlay on HD video stream that includes ROV heading, depth, embedded in the closed captioning channel
- HD video digital recording system. Full redundancy, at 50 mbs

Manipulators:

- Starboard - spatially correspondent, 7 function manipulator, with force feedback 79 inches of reach, 200 lb lift
- Port - spatially correspondent, 7 function manipulator, with force feedback 79 inches of reach, 200 lb lift
- Webtool Hydraulic Cutter WCO38DLP operating at 3000psi

Sample Equipment:

- Variable speed suction sampler with 8 discreet 2-litre sample bottles. Each bottle can be configured for specific sample and filtration sizes
- 2 x Swing arms capable of 5 cores tubes each side or sampling boxes.
- Up to 10 Core tubes capable of collecting mud core 2 5/8" in diameter x 14" in length
- large Lexan collection boxes with 4.3 cubic feet of capacity
- Seabird 19 plus V2 CTD with SBE 18 pH sensor and SBE 43 Oxygen sensor streaming data to the surface console

Other Equipment

- 10 independent, two way hydraulic functions that can be used to trigger client samplers or other tools

Electrical interfaces

- External junction box provides 24VDC, +/- 12VDC and 5VDC to the user interface as well as access to the RS-232 ports
- Seven bi-directional user RS-232 channels; independent of vehicle telemetry
- Ability to install and integrate up to 7 customer furnished external sensors
- 2 x composite video channels for customer furnished video or high bandwidth device.
- 1 x 100bT Ethernet channel for customer furnished Ethernet device.
- 1 x optical fibre path for customer furnished equipment.

Navigation System

- USBL system capable of accuracy better than 0.5% of slant range
- USBL system must be pre-calibrated and not require calibration on board the vessel
- Sound Velocity Sampler integrated into vehicle system to provide real-time correction for sound velocity changes in water column. Required for the complex water conditions encountered during these surveys.
- IXSEA Octans Fibre Optic Gyrocompass

- High Resolution Doppler Velocity Logger integrated into Navigation System, processed with a Kalman filter for “Best Fit” Nav solution.

Data management:

- Integrated Real-time Logging System includes:
  - Navigation logs
  - Date, time, and navigation comments stamped onto video frame grabs, sample logs, digital still photographs.
  - Data provided in redundant files to client at job end.
  - Annotated HD digital video provided to client at job end

Launch and Recovery System

- System designed and maintained to meet or exceed American Bureau of Shipping requirements for certification of lifting appliances.
- System designed and maintained to meet or exceed Canadian Tackle Regulations
- System capable of through frame lift of up to 4000 pound loads suspended in the air under the vehicle.
- System capable of in-water through frame lift of up to 5000 lb (depending on depth) WHILE MEETING ABS and CTR requirements.
- SAFE vehicle launch and recovery in varied sea states. No applying floats on deck to a dynamic cable. No handling of vehicle tether while vehicle is on the surface at the ship’s stern.

Regional Scale Nodes

Quote Cover Sheet

RSN Quote Number	**4120-66406**
For:	Satellite transponder
Type:	Official Quote
Date:	March 29, 2011
Company:	INTELSAT
Requested By:	John Delaney

Notes:

INTELSAT

March 29, 2011

Mr. David Robertson
Video Network Engineer
University of Washington – UWTV
17G Kane Hall, Box 353090
Seattle, WA 98195

Dear Dave,

Intelsat is delighted to provide a quotation for your Oceanography project utilizing a two way carrier as follows:

- Dates of service: Full time transponder service beginning August 8, 2011 through September 1, 2011

- Total days of usage: 25

- Satellite: Galaxy 18, Ku-Band

- Uplink Polarity: Vertical

- Total bandwidth allocation: 5 Mbps ship to shore and 3 Mbps shore to ship = 4.25 MHz total (Engineering estimates the bandwidth to be a bit lower than last year)

- Charges: $30,198.00 for 25 days usage

For the three periods of 6 hours each period, whereby you are interested in transmitting 20 Mbps (assuming 18 MHz will be used) , Intelsat can provide these services on transponder 24K which is a vertical uplink through our OU transponder pool. The rate for three, 6 hour slots (18 hours total) will be $8424.00 ($468.00 per hour)

If you have the times for August 14, 20 and 28th, please pass them along and I will have this scheduled as a pencil booking for now, to reserve the time.

When you are ready to test your small carriers in the coming weeks, we will determine whether we will allocate the needed bandwidth from our OU pool or if it will come from the full time pool. Currently the smallest OU pool bandwidth slice is 4.5 MHz. If you can use this allocation and use only what you need through the OU pool, we can provide this testing at no charge.

If you need exactly the parameters you mentioned, I will be required to pull the bandwidth from the full time pool and have it allocated through a temporary access contract (TAC). This will take a few days to process internally. That being said, we should be mindful of the timing of the services and your expectations for implementation of the test. If you choose to use a TAC for this service, I can arrange the test portions for you at no charge.

I am looking forward to seeing you in Las Vegas and helping to implement this project for University of Washington.

Sincerely,

Rebecca Cassells

Rebecca Cassells
Senior Sates Director
Intelsat Media Solution

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