REVISIONS			
REV	DESCRIPTION	DATE	APPROVAL
1-00	Initial Release	13 October 2008	
1-01	Amend sensor list	25 October 2008	
1-02	Format and Review	31 October 2008	
2-00	Revisions per ECR 1303-00039	19 May 2010	D.Wickman
2-01	Revisions per ECR 1303-00090; removed version numbers from Site Characterization papers	09 July 2010	D. Wickman
2-02	Revision per ECR 1303-00183	6 January 2011	S. White
2-03	Revision per ECR 1303-00332	13 May 2011	CG CCB

OCEAN OBSERVATORIES INITIATIVE

CGSN Coastal & Global Scale Nodes

Global Surface Piercing Profiler Specification

SIZE	DOCUMENT TYPE	DWG NO.	REV
	Specification	**3310-00005**	**2-03**

Contents

1.0 Scope

This document describes the specification requirements for the Global Surface Piercing Profiler. The specification describes the physical, functional and electrical characteristics of the Global Surface Piercing Profiler (GSPP).

2.0 Purpose

The purpose of this specification is to provide the requirements for the Global Surface Piercing Profiler for use in the Ocean Observatories Initiative (OOI).

Moored profilers are one of the primary measurement tools used in the Coastal and Global Scale Nodes (CGSN) to obtain time series of the vertical profile of important variables in the oceans. In general, moored profilers consist of a suite of sensors that are raised and lowered through the water column on a regular basis.

A Global Surface Piercing Profiler is mounted at the upper end of a conventional subsurface oceanographic mooring. The mooring is held in a fixed geographic location by an anchor. At the upper end of the mooring, at a depth of about 200 meters, a large floatation buoy maintains tension in the mooring and keeps it vertical. Instruments are deployed along the mooring line connecting the upper float to the anchor. The Global Surface Piercing Profiler is mounted above the near-surface floatation and raises sensors all the way to the surface. When the Profiler has surfaced, a telemetry system sends data back to shore using a satellite link. It also receives commands from shore to alter the operation of the profiler, the sensor package, and the processing performed on the data. The Profiler communicates with instruments on the mooring line below the near-surface floatation using an inductive modem. The Profiler collects their data, relays it to shore, and passes on to them any commands that have come from the shore station.

The goal is to have the Global Surface Piercing Profiler profile from the surface to as close to the depth of the near-surface floatation as practical. The threshold of acceptance is that a depth of 150 meters must be attainable, but the ability to get even deeper is desirable. Ocean currents acting on the mooring will tend to submerge the near-surface floatation, and this will submerge the Profiler to greater depths. The vendor must provide for this to allow operation all the way to the surface under conditions as described in these specifications. The vendor must supply a physical model or software tool relating the possible profiling range to velocity of currents and the subduction depth of the sub-surface floatation.

The Global Surface Piercing Profiler will be deployed in the open ocean far from shore in waters as deep as 5200 meters and will be maintained at thirteen month intervals.

3.0 Reference

3.1 Reference Documents

The specifications of the Global Surface Piercing Profiler system are derived from the requirements listed in the OOI requirement module based on the end item use defined in the Final Network Design (FND) 1101-00000 (available upon request).

Global Surface Piercing Profiler Interface Control Document (TBS) – to define mechanical and communications interface.

The following White Papers describe the site characteristics and environmental conditions of the global deployment sites (available on request):

- CGSN Site Characterization: Southern Ocean Array (3201-00007)
- CGSN Site Characterization: Irminger Sea Array (3202-00007)
- CGSN Site Characterization: Station Papa Array (3203-00007)
- CGSN Site Characterization: Argentine Basin Array (3206-00007)

3.2 General Definitions

Certificate of Compliance – a certificate provided by the manufacturer stating that the unit is compliant with the requirements in the specification, has passed testing with records maintained by QA/QC at the vendor, and contains materials as agreed at the design reviews.

Deployment Interval – The period between launch and recovery.

Mission – An operational task, defined by a mission plan, during which the vehicle is active and sampling.

Mission Plan – A set of vehicle and sensor commands defining vehicle trajectory and sampling protocols; mission parameters include but are not limited to profiling depth, speed, sensors active and sensor sampling rates, data compaction and selection for telemetry to shore.

Operate – Correctly performing the designed functionality.

Shore station – In the context of these specifications, observatory management center(s) used to command and control profilers during a deployment through the use of bi-directional satellite communications (Iridium). The profilers will communicate with the shore station when the profiling body has pierced the surface of the ocean.

Survive – Experience an event without major loss of hardware. System may experience loss of functionality requiring repair to return to normal mode functionality.

Sustain – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during the event.

4.0 Specifications

Note: Specifications are assigned unique identifications specific to this document. Specifications tied directly to Global Surface Piercing Profiler requirements maintained in the database are followed by the requirement number in square brackets, e.g., [L4-CG-PR-RQ-110]. The requirement number is intended for internal OOI use.

4.1 Manufacturing Requirements

MANU-001: To the greatest extent practical, all infrastructure of the Global Surface Piercing Profiler shall be compatible with applicable national and international standards, including those of the IEEE, ANSI, and IEC.

MANU-002: The materials used in construction of the profilers, sensors, and sensor mounts shall be chosen and treated in such a way as to reduce the levels of wear, corrosion and deterioration to allow multiple deployments of each unit. [L4-CG-PR-RQ-195]

MANU-003: All structural and electrical cables on a profiler deployed at depths shallower than 1000 m shall be protected from fish bite. [L4-CG-PR-RQ-181]

MANU-004: The Global Surface Piercing Profiler shall be capable of sustaining a pressure of 500 decibars. [L4-CG-PR-RQ-350]

MANU-005: The Global Surface Piercing Profiler should be capable of sustaining a pressure of 1000 decibars. This is an objective. [L4-CG-PR-RQ-351]

4.2 Performance Requirements

4.2.1 Operating Environment

OPEN-001: The Global Surface Piercing Profiler shall be capable of profiling from the ocean surface to a depth of 150m or more. [L4-CG-PR-RQ-110]

OPEN-002: The Global Surface Piercing Profiler should operate in conditions of winds up to 30 $m \cdot s^{-1}$ and maximum wave heights up to 11 meters. This is an objective. [L4-CG-PR-RQ-111]

OPEN-006: The Global surface piercing Profiler shall operate in conditions of winds up to 13 $m \cdot s^{-1}$ and maximum wave heights up to 4 meters. [L4-CG-PR-RQ-353]

OPEN-003: (*Reserved*)

OPEN-004: (*Reserved*)

OPEN-005: The attachment point of the Global Surface Piercing Profiler to the supporting mooring is at a nominal depth of 200 meters below the surface. The Global Surface Piercing Profiler shall be capable of profiling to the surface in the absence of currents when the attachment point has been subducted to a depth of up to 400 meters.

4.2.2 Power

POWR-001: The Global Surface Piercing Profiler shall be powered from an internal source which shall be sufficient to operate for the entire deployment interval. [L4-CG-PR-RQ-120]

POWR-002: The Global Surface Piercing Profiler shall be able to complete 2 roundtrip profiles per day over the entire profiling range for the duration of the deployment interval. [L4-CG-PR-RQ-115]

POWR-003: The Global Surface Piercing Profiler shall have the capability to reduce overall system functionality as power becomes limited or when directed by commands from the shore station. [L4-CG-PR-RQ-203]

4.2.3 Communications

COMS-001: The Global Surface Piercing Profiler shall be capable of surfacing and transferring a subset of the data to shore using a bidirectional Iridium satellite link. [L4-CG-PR-RQ-134] [L4-CG-PR-RQ-208]

COMS-002: The Global Surface Piercing Profiler shall have the capability to send engineering data to a shore station via Iridium satellite link. [L4-CG-PR-RQ-209]

COMS-003: The Global Surface Piercing Profiler shall have the capability to receive commands from a shore station via Iridium satellite link. [L4-CG-PR-RQ-210]

COMS-004: The Global Surface Piercing Profiler shall have the capability to control and monitor the telemetry subsystem. [L4-CG-PR-RQ-202]

COMS-005: The Global Surface Piercing Profiler shall include a bidirectional inductive telemetry system to communicate data and commands with instruments on the same mooring. [L4-CG-PR-RQ-142]

4.2.4 Sensor Payload

(See Section 5.0 for a list of sensors referred to in this section.)

SENS-001: The sensors are an integral part of the Global Surface Piercing Profiler and shall be provided, installed and integrated with each delivered unit.

SENS-002: The Global Surface Piercing Profiler shall measure Conductivity, Temperature, and Depth (CTD). [L4-CG-PR-RQ-121]

SENS-003: The Global Surface Piercing Profiler shall measure Dissolved Oxygen (DO). [L4-CG-PR-RQ-122]

SENS-004: The Global Surface Piercing Profiler shall measure Chlorophyll a Fluorescence and Optical Backscatter. [L4-CG-PR-RQ-124]

SENS-005: The Global Surface Piercing Profiler shall measure the Partial Pressure of Carbon Dioxide (pCO2) in water. [L4-CG-PR-RQ-291]

SENS-006: The Global Surface Piercing Profiler shall measure multispectral optical attenuation and absorption. [L4-CG-PR-RQ-126]

SENS-007: The Global Surface Piercing Profiler shall measure Spectral Irradiance. [L4-CG-PR-RQ-127]

SENS-008: The Global Surface Piercing Profiler shall measure Nitrate. [L4-CG-PR-RQ-128]

SENS-009: The Global Surface Piercing Profiler shall sample all sensors at least once in every 25 cm of vertical travel. [L4-CG-PR-RQ-132]

SENS-0010: The Global Surface Piercing Profiler shall have the capability to monitor the orientation (attitude and heading) of the profiling body. [L4-CG-PR-RQ-335]

4.2.5 Data Handling

DATA-001: The Global Surface Piercing Profiler shall have the capability to turn off sensors or instruments that malfunction or when directed by commands from the shore station. [L4-CG-PR-RQ-204]

DATA-002: The Global Surface Piercing Profiler shall contain a GPS receiver capable of acquiring a fix with a minimum of 3 satellites within 5 minutes of surfacing 90% of the time. [L4-CG-PR-RQ-143]

DATA-003: The Global Surface Piercing Profiler shall contain a real time clock which can be synchronized to UTC with an accuracy of +/- 1 second using the GPS receiver. [L4-CG-PR-RQ-144]

DATA-004: The Global Surface Piercing Profiler shall stamp all data with the time of acquisition obtained from the real-time clock. [L4-CG-PR-RQ-144]

DATA-005: The Global Surface Piercing Profiler shall time-stamp and store all data from sensors in non-volatile memory. [L4-CG-PR-RQ-205]

DATA-006: The data storage subsystem shall have data storage capacity to store all of the engineering data and sensor data collected during the maintenance interval. [L4-CG-PR-RQ-207]

DATA-007: The data and command communication protocol shall employ an error detection/correction protocol. [L4-CG-PR-RQ-212]

4.2.6 Operations and Maintenance

OPSM-001: The Global Surface Piercing Profiler shall assess the surface wave conditions by measuring pressure fluctuations, tension, acceleration of the profiling body or other means, and shall avoid surfacing of the sensor package in conditions deemed hazardous to the profiler. [L4-CG-PR-RQ-198]

OPSM-002: The Global Surface Piercing Profiler shall respond to commands from a remote shore station via Iridium satellite to change the operation of the profiler, sensor package, sensors, and telemetry system. [L4-CG-PR-RQ-211]

OPSM-003: The Global Surface Piercing Profiler shall have the capability to control and monitor the vertical velocity of the sensor package. [L4-CG-PR-RQ-199]

OPSM-004: The Global Surface Piercing Profiler shall have the capability to control and monitor the range of vertical motion of the sensor package. [L4-CG-PR-RQ-200]

OPSM-005: The Profiler shall have the capability to control and monitor the data acquisition and storage of sensor data. [L4-CG-PR-RQ-201]

OPSM-006: The Profiler shall monitor the health of subsystems and record the time-stamped engineering data in non-volatile memory. [L4-CG-PR-RQ-206]

OPSM-007: The profiling package of the Global Surface Piercing Profiler shall contain an emergency position locator, such as a System Argos beacon or equivalent to allow the location and recovery should it become detached from the main body. [L4-CG-PR-RQ-145]

OPSM-008: The Global Surface Piercing Profiler shall be recoverable and reusable following refurbishment and refueling. [L4-CG-PR-RQ-183]

OPSM-009: The science sensors on a Profiler shall be user-replaceable in the field with identical spare sensors without requiring the opening of the pressure housing. [L4-CG-PR-RQ-182

OPSM-010: Science sensor replacement (with identical spares) shall require no modification to the profiler hardware or software. On board storage of instrument serial numbers and calibration coefficients is not construed as modification to profiler software. [L4-CG-PR-RQ-196]

OPSM-011: The designed maintenance and operation interval for the Global Surface Piercing Profiler shall be thirteen months. [L4-CG-PR-RQ-114]

OPSM-012: The vendor shall supply operation manual(s) detailing operation, maintenance, handling, and shipping of the Global Surface Piercing Profiler.

OPSM-013: The Global Surface Piercing Profiler shall be deployable by UNOLS ships. [L4-CG-PR-RQ-308]

OPSM-014: The vendor shall provide a mission planning tool to provide estimates of energy usage as a function of sensor payload and sampling interval. [L4-CG-PR-RQ-184]

OPSM-015: The mission planning tool shall provide estimates of energy usage as a function of profiling speed, vertical profiling speed, current speed, and in situ water density. [L4-CG-PR-RQ-213]

OPSM-016: The mission planning tool shall provide estimates of the data storage needs as a function of sensor payload and sampling interval. [L4-CG-PR-RQ-214]

OPSM-017: The mission planning tool shall monitor the power usage of a deployed profiler and provide estimates of the capacity remaining. [L4-CG-PR-RQ-216]

OPSM-018: The mission planning tool shall monitor the data storage usage of a deployed profiler and provide estimates of the capacity remaining. [L4-CG-PR-RQ-217]

OPSM-019: The mission planning tool shall provide estimates of the telemetry bandwidth requirements as a function of sensor payload, sampling interval, and data decimation options. [L4-CG-PR-RQ-215]

OPSM-020: The vendor shall provide a modeling tool to predict the influence of ocean currents upon the profiling range of the Profiler. The model may assume uniform, unidirectional currents throughout the range of the Profiler. A tabulation or datasheet summarizing the results is acceptable. In any case, all drag coefficients, wetted areas, and other assumptions made in the calculations must be listed. Current speeds up to 1 meter per second are sufficient.

4.3 Quality Requirements

4.3.1 Manufacturing

QUAL-001: The Global Surface Piercing Profiler shall be manufactured in accordance with the manufacturer's best practices. Records of quality assurance tests and inspections shall be available for review by the purchaser.

QUAL-003: The manufacturer of the Global Surface Piercing Profiler should have an ISO-9001:2008 certified Quality Management System. This is an objective.

4.3.2 Certificate of Compliance

QUAL-002: A certificate of compliance shall be provided with each delivered unit. The certificate of compliance shall be supported with copies of the Factory Acceptance Test report and calibration records for each sensor following integration into the unit.

4.4 Identification and Traceability Requirements

4.4.1 Global Surface Piercing Profiler Marking

IDNT-001: Global Surface Piercing Profiler shall be marked indelibly on an exterior surface. Marking shall include:

- Manufacturer's part number
- Unit serial number
- CGSN part number for the Global Surface Piercing Profiler: "P/N 3310-00005-00001"

4.4.2 Transportation Case Marking

IDNT-002: Global Surface Piercing Profiler transportation cases shall have external labels specifying safe handling precautions.

4.5 Handling, Packaging, Shipping, and Storage Requirements

4.5.1 Storage temperature

SHIP-001: Profiler shall be capable of being stored without damage or degradation between 0° F and 120° F for periods of up to 1 year.

4.5.2 Transportation environment

SHIP-002: The profiler in its transportation case must survive shipping conditions defined by ASTM D4169 truck assurance level 1.

4.5.3 Shipping

SHIP-003: Units shall be delivered with a reusable transportation case via commercial carrier to the address specified in the contract or purchase order.

5.0 Attachments

Global Surface Piercing Profiler Instrument List

SPECIFICATIONS FOR CONDUCTIVITY TEMPERATURE DEPTH (CTD) INSTRUMENTS ON MOBILE ASSETS AND PROFILERS

Version 2-00
Document Control Number 1331-00001
2011-03-10

Consortium for Ocean Leadership
1201 New York Ave NW, 4th Floor, Washington DC 20005
www.OceanLeadership.org

in Cooperation with

University of California, San Diego
University of Washington
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

Document Control Sheet

Version	Date	Description	Originator
0-01	5/18/2010	Derived Profiler specs from general CTD spec.	Rob DelCoco
0-02	5/19/2010	Changed title to include all mobile assets and profilers	Rob DelCoco
0-03	5/19/2010	Added SALT -002 and COND-001 to account for wire following profilers on CG that descend to 120 meters or less	Lorraine Brasseur
1-00	5/21/2010	Corrections from SE (typos only)	Lorraine Brasseur
1-01	6/1/2010	Added pres-002 and adjusted pres-001 to correct for depth range on profilers as opposed to mobile assets – discussed with SE; removed draft watermark, formatting for OOI compatibility	Lorraine Brasseur
1-02	10/15/2010	Modified SALT and COND to be consistent with the CTD spec for fixed platforms as directed by 10/15 CCB.	Rob DelCoco
1-03	1/24/2010	Updated the mobile CTD Spec to be consistent with the new spec template	Jennifer Dorton
1-04	2/2/2011	Minor corrections	Jennifer Dorton
1-05	2/15/2011	Made corrections to Section 1.2 and updated the requirements based on info provided by Art.	Jennifer Dorton
1-06	2/16/2011	Updated spec based on corrections/explanations from Al Plueddemann	Jennifer Dorton
1-07	2/18/2011	Updated spec based on discussions with Lorraine & Ed.	Jennifer Dorton
1-08	2/22/2011	Updated traceability to new requirements.	Ed Chapman
1-09	2/25/2011	Update based on CCB	Lorraine Brasseur
1-10	3/02/2011	Refined pump and accuracy specs.	Lorraine Brasseur Al Plueddemann

1-11	3/10/2011	Liens from ECR #1300-00130	Ed Chapman
2-00	3/10/2011	Release version. ECR#1300-00130	Ed Chapman

Signature Page

This document has been reviewed and approved for release to Configuration Management.

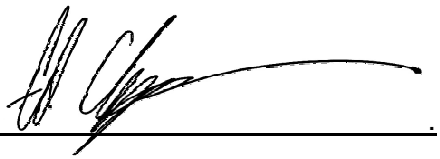
OOI Senior Systems Engineer:  .

Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) will lay the foundation for future ocean science observations. OOI will enable powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI will enable multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers will control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

1.2 Document Scope and Purpose

This document contains the specifications for conductivity, temperature, depth (CTD) instruments for use on mobile platforms assets and profilers for the OOI. These assets include buoyancy-driven gliders, propeller-driven Autonomous Underwater Vehicles (AUVs), wire-following profilers, and moored shallow/surface piercing profilers.

Gliders are buoyancy-driven, battery powered underwater vehicles that achieve propulsion by changing their volume by pumping to or from an oil-filled bladder. When they dive or rise, the glider's wings achieve lift allowing the glider to fly forward through the water. They can achieve speeds of about one tenth of those of the AUVs or ~25 to 35 cm s^{-1}. At the surface, gliders acquire position information using GPS and transmit data and receive commands via satellite.

AUVs are somewhat like instrumented torpedoes, though optimized for longer life at slower speeds while carrying a sensor payload. Optimum speeds for AUVs used in oceanographic applications are near 1.7 m s^{-1}, while maximum speeds of about 2.5 m s^{-1} may be reached. AUVs have a high payload capacity relative to gliders, and will carry a broad suite of sensors for

interdisciplinary observations. They surface to obtain position fixes using GPS and while at the surface they also enter the OOI communications network using satellite telemetry.

Moored wire-following profilers contain a suite of sensors that are raised and lowered through the water column on a regular basis. These are generally used for deep measurements and profiles that can extent to more than 1000 meters in depth. It is expected that these profilers will move vertically at speeds up to about 0.25 m/s.

Moored shallow/surface piercing profilers are expected to be deployed in the shallowest 200 meters of the water column on OOI arrays. These profilers will carry a somewhat larger payload than wire-following profilers and can move vertically at speeds up to 0.5 m/s

1.3 Documents

1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, D.C. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/

1.3.2 Applicable

These documents contain requirements and specifications applicable to the instrument specified. The referenced section, requirement, or specification shall be met by the instrument specified herein.

- N/A

1.4 Definitions

1.4.1 Glossary and Acronyms

- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measure and (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **AUV** – Autonomous Underwater Vehicle
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **CTD** – Conductivity, Depth and Temperature
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.
- **OOI** – Ocean Observatories Initiative

- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.
- **Operate** – Correctly performing designed functionality.
- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **Survive** – Experience an event without major loss of hardware. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is a glider loss resulting in the glider and its on-board instrument suite descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.
- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

The numbering of the specification statements (Such as “COND-005” appearing before COND-001) is for compatibility with a legacy specification and is not meant to imply any sort of priority.

2 Specifications

2.1 Measurement

Values provided are threshold unless otherwise stated.

2.1.1 Salinity Calculation Accuracy

SALT-001 For all CTD instruments, conductivity, temperature, and pressure measurements shall be collected such that salinity calculated using UNESCO Seawater Equations of State (Fofonoff and

Millard, 1983) has an accuracy in the laboratory of ±0.005 on the Practical Salinity Scale (PSS). <L2-SR-RQ-3143, L2-SR-RQ-3468, L2-SR-RQ-3684, L2-SR-RQ-3486>

SALT-002 For CTD instruments on profilers that do not ascend to shallower than 200 m, conductivity, temperature, and pressure measurements shall be collected such that salinity calculated using UNESCO Seawater Equations of State (Fofonoff and Millard, 1983) has an accuracy of ±0.005 on the PSS for a full deployment interval. < L2-SR-RQ-3143, L2-SR-RQ-3468, L2-SR-RQ-3486>

SALT-003 For CTD instruments on profilers that ascend to shallower than 200 m, conductivity, temperature, and pressure measurements shall be collected such that salinity calculated using UNESCO Seawater Equations of State (Fofonoff and Millard, 1983) has an accuracy of ±0.01 on the PSS for a full deployment interval. < L2-SR-RQ-3143, L2-SR-RQ-3468, L2-SR-RQ-3486>

SALT-004 For CTD instruments on gliders and AUVs, conductivity, temperature, and pressure measurements shall be collected such that salinity calculated using UNESCO Seawater Equations of State (Fofonoff and Millard, 1983) has an accuracy of ±0.005 on the PSS for a full deployment interval. < L2-SR-RQ-3143, L2-SR-RQ-3468, L2-SR-RQ-3486>

2.1.2 Conductivity Measurements

a) Measurement with unit(s)

Conductivity ($S \cdot m^{-1}$)

b) Minimum Value

COND-005a CTD instruments on mobile assets and profilers shall measure conductivity over a range with a minimum value of 0 $S \cdot m^{-1}$. <L2-SR-RQ-3474, L4-CG-IP-RQ-171L4-RSN-IP-RQ-288>

c) Maximum Value

COND-005b CTD instruments on mobile assets and profilers shall measure conductivity over a range with a maximum value of 7 $S \cdot m^{-1}$. <L2-SR-RQ-3474, L4-CG-IP-RQ-171, L4-RSN-IP-RQ-288>

d) Accuracy

COND-001 For CTD instruments on mobile assets and profilers, conductivity measurements shall have an accuracy in the laboratory of ±0.0003 $S \cdot m^{-1}$ for all instruments. <L2-SR-RQ-3471, L4-CG-IP-RQ-166, L4-RSN-IP-RQ-287>

COND-002 Conductivity measurements shall have an accuracy, for the full deployment interval, of ±0.0003 $S \cdot m^{-1}$ for CTD instruments on profilers that do not ascend to shallower than 200 m.

COND-003 Conductivity measurements shall have an accuracy, for the full deployment interval, of ±0.001 $S \cdot m^{-1}$ on CTD instruments on profilers that ascend to shallower than 200 m.

COND-007 Conductivity measurements shall have an accuracy, for the full deployment interval, of ±0.0003 $S \cdot m^{-1}$ for CTD instruments on gliders and AUVs.

e) Precision

Not specified

f) Resolution

COND-006 Conductivity measurements shall have a resolution ±0.00001 $S \cdot m^{-1}$ for CTD instruments on mobile assets and profilers. <L2-SR-RQ-3472, L4-CG-IP-RQ-167, L4-RSN-IP-RQ-286>

g) Drift

COND-004 For CTD instruments on mobile assets and profilers, conductivity measurements shall have an annual drift of no more than 0.004 $S \cdot m^{-1}$. <L2-SR-RQ-3473, L4-CG-IP-RQ-344, L4-RSN-IP-RQ-477>

h) Response Times

Not specified

i) Sampling Frequency

COND-008 For CTD instruments on mobile assets and profilers, conductivity shall be sampled at a frequency of 1 Hz. < L4-CG-IP-RQ-440, >

j) Dependencies

2.1.3 Temperature Measurements

a) Measurement with unit(s)

Temperature (°C)

b) Minimum Value

TEMP-003a CTD instruments on mobile assets and profilers shall measure temperature over a range with a minimum value -2°C. <L2-SR-RQ-3463, L4-CG-IP-RQ-163, L4-RSN-IP-RQ-289>

c) Maximum Value

TEMP-003b CTD instruments on mobile assets and profilers shall measure temperature over a range with a maximum value of 35°C. <L2-SR-RQ-3463, L4-CG-IP-RQ-163, L4-RSN-IP-RQ-289>

d) Accuracy

TEMP-001 For CTD instruments on mobile assets and profilers, temperature measurements shall have an accuracy, for the full deployment interval, of ± 0.002º C. <L2-SR-RQ-3465, L4-CG-IP-RQ-342, L4-RSN-IP-RQ-291>

e) Precision

Not specified

f) Resolution

TEMP-004 For CTD instruments on mobile assets and profilers, temperature measurements shall have a resolution of 0.0001º C. <L2-SR-RQ-3461, L4-CG-IP-RQ-159 >

g) Drift

TEMP-002 For CTD instruments on mobile assets and profilers, temperature measurements shall have an annual drift of no more than 0.01º C per year. <L2-SR-RQ-3462, L4-CG-IP-RQ-343, L4-RSN-IP-RQ-478>

h) Response Times

i) Sampling Frequency

TEMP-005 For CTD instruments on mobile assets and profilers, temperature measurements shall be sampled at a frequency of 1 Hz. <L2-SR-RQ-3460, L4-CG-IP-RQ-162>

j) Dependencies

2.1.4 Pressure (Depth) Measurements

a) Measurement with unit(s)

Pressure (dbar)

b) Minimum Value

PRES-001a CTD instruments on mobile assets and profilers shall measure pressure over a range with a minimum value of 0 dbar. <L2-SR-RQ-3478, L2-SR-RQ-3479, L4-CG-IP-RQ-347, L4-CG-IP-RQ-180, L4-RSN-IP-RQ-292>

c) Maximum Value

PRES-001b CTD instruments on mobile assets and profilers shall measure pressure over a range with a maximum value that meets the full operational depth range of the host platform. <L2-SR-RQ-3478, L2-SR-RQ-3479, L4-CG-IP-RQ-347, L4-CG-IP-RQ-180, L4-RSN-IP-RQ-292>

d) Accuracy

PRES-003 CTD instruments on mobile assets and profilers shall measure pressure with an accuracy of ±0.1% of the maximum operational depth range. <L2-SR-RQ-3481, L2-SR-RQ-3480, L4-CG-IP-RQ-174, L4-CG-IP-RQ-176, L4-RSN-IP-RQ-294>

e) Precision

While precision is important to this measurement, a threshold value for precision is not provided in this document.

f) Resolution

PRES-005 For CTD instruments on mobile assets and profilers, pressure sensors shall have a resolution of 0.002% of the maximum value of its operational depth <L2-SR-RQ-3482, L2-SR-RQ-3483, L4-CG-IP-RQ-175, L4-CG-IP-RQ-177, L4-RSN-IP-RQ-293>

g) Drift

PRES-004 For CTD instruments on mobile assets and profilers, pressure sensors shall have an annual drift of no more than 0.05% of the maximum value of the operational depth range. < L2-SR-RQ-3485, L2-SR-RQ-3484, L4-CG-IP-RQ-345, L4-CG-IP-RQ-346, L4-RSN-IP-RQ-479>

h) Sampling Frequency

PRES-006 For CTD instruments on mobile assets and profilers, pressure measurements shall be sampled at a frequency of 1 Hz.

i) Dependencies

(Note: There is no PRES-002 statement.)

2.2 Operational

2.2.1 Operational Depth Range

See platform specifications

2.2.2 Environmental

See platform specifications

2.2.3 Service Requirements

See platform specifications

2.2.4 Calibration Requirement

MECH-001 CTD instruments on open ocean profilers shall operate for at least 13 months without recalibration. < L4-CG-IP-RQ-286, LR-RSN-IP-RQ-295>

MECH-005 CTD instruments on coastal profilers shall operate for at least 7 months without recalibration. < L4-CG-IP-RQ-286>

MECH-006 CTD instruments on gliders and AUVs shall operate for at least 3 months without recalibration. < L4-CG-IP-RQ-286>

2.2.5 Maintenance Interval

See platform specifications

2.3 Mechanical/Physical

2.3.1 Materials

See platform specifications

2.3.2 Size

See platform specifications

2.3.3 Weight

See platform specifications

2.3.4 Pump

MECH-002 The CTD instrument shall include a pump or equivalent design solution that fulfills the same purposes. The purposes of a pump are 1) controlled flow, especially in regions of reduced or obstructed flow 2) reduced biofouling,

2.3.5 Additional Instruments

MECH-003 The CTD instrument's pump should be capable of supporting additional instruments. This is an objective.

MECH-004 CTD instruments should be capable of supporting additional instruments. Support shall consist of power, command and control, and data recording. This is an objective.

2.4 Electrical

See platform specifications

2.5 Data Storage and Processing

See platform specifications

2.6 Software/Firmware

See platform specifications

2.7 Platform Interfaces

See platform specifications

2.8 Compliance

See platform specifications

2.9 Safety

See platform specifications

2.10 Shipping and Storage

See platform specifications

2.11 Identification

See platform specifications

2.12 Quality

See platform specifications

3 Documentation

3.1 Documentation

See the RFP for documentation that the vendor shall be required to supply.

SPECIFICATIONS FOR DISSOLVED OXYGEN INSTRUMENTS ON MOBILE ASSETS AND PROFILERS

Version 2-00
Document Control Number 1331-00002
2011-03-04

Consortium for Ocean Leadership, Inc.
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in Cooperation with

University of California, San Diego
University of Washington
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

Document Control Sheet

Version	Date	Description	Originator
0-01	05/18/2010	Wrote spec from combined DO spec that was vetted by the SWG group on 5/12/2010	Lorraine Brasseur
0-02	5/19/2010	Andrew Dickson comments, changed document number and added language for all mobile assets and profilers	Lorraine Brasseur
0-03	5/19/2010	SWG 5/19 comments addressed – these included accuracy redevined, change of response time, revising units to mol/kg	Lorraine Brasseur
0-04	5/21/2010	Kendra Daly and Andrew Dickson followup to drift and response time – drift is now more stringent and e-folding language removed from response time for clarity	Lorraine Brasseur
1-00	5/25/2010	Updated SE comments – word choice and clarity and revised external power and data storage added ELEC-002; fixed error in SAMP-001 that should have been caught earlier - was updated correctly in 1336	Lorraine Brasseur
1-01	6/1/2010	SE approved; formatting	Lorraine Brasseur
1-02	1/14/2011	Converted to new spec template; updates in concert with fixed platform spec version 1-04.	Arthur Salwin (Noblis)
1-03	1/21/2011	Revised document scope and purpose; removed CTD interface specs	Arthur Salwin (Noblis)
1-04	1/28/2011	Added sampling frequency spec for RSN shallow profiler	Arthur Salwin (Noblis)
1-05	02/08/2011	Addressed comments on ECR # 1300-00113 and 1300-00115	Arthur Salwin (Noblis)
1-06	02/09/2011	Addressed DO2-006 with Giora Proskurowski, Kendra Daly, Leslie Smith, Jack Barth	Lorraine Brasseur
1-07	02/15/2011	Minor edits	Arthur Salwin (Noblis)
1-08	03/03/2011	Added references to new requirements	Arthur Salwin (Noblis)
1-09	03/04/2011	Removed sampling frequencies	Arthur Salwin (Noblis)
2-00	03/04/2011	Approved baseline	Ed Chapman

Signature Page

This document has been reviewed and approved for release to Configuration Management.

OOI Senior Systems Engineer:  .

Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) will lay the foundation for future ocean science observations. OOI will enable powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI will enable multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers will control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

1.2 Document Scope and Purpose

This document provides specifications for instruments on mobile assets and profilers that measure dissolved oxygen in seawater. These assets include buoyancy-driven gliders, propeller-driven Autonomous Underwater Vehicles (AUVs), wire-following profilers, and moored shallow/surface piercing profilers.

Gliders are buoyancy-driven, battery-powered underwater vehicles that achieve propulsion by changing their volume by pumping to or from an oil-filled bladder. When they dive or rise, the glider's wings achieve lift allowing the glider to fly forward through the water. They can achieve speeds of about one tenth of those of the AUVs or ~25 to 35 cm s^{-1}. At the surface, gliders acquire position information using GPS and transmit data and receive commands via satellite.

AUVs are somewhat like instrumented torpedoes, though optimized for longer life at slower speeds while carrying a sensor payload. Optimum speeds for AUVs used in oceanographic applications are near 1.7 m s^{-1}, while maximum speeds of about 2.5 m s^{-1} may be reached. AUVs have a high payload capacity relative to gliders, and will carry a broad suite of sensors for interdisciplinary

observations. They surface to obtain position fixes using GPS and while at the surface they also enter the OOI communications network using satellite telemetry.

Moored wire-following profilers contain a suite of sensors that are raised and lowered through the water column on a regular basis. These are generally used for deep measurements and profiles that can extent to more than 1000 meters in depth. It is expected that these profilers will move vertically at speeds up to about 0.25 m/s.

Moored shallow/surface piercing profilers are expected to be used in the first 200 meters of the water column on OOI arrays. These profilers will carry a somewhat larger payload than wire-following profilers and can move vertically at speeds up to 0.5 m/s.

1.3 Documents

1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, D.C. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/

1.3.2 Applicable

These documents contain requirements and specifications applicable to the instrument specified. The referenced section, requirement, or specification shall be met by the instrument specified herein.

N/A

1.4 Definitions

1.4.1 Glossary and Acronyms

- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measurand (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.
- **OOI** – Ocean Observatories Initiative
- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.
- **Operate** – Correctly performing designed functionality.

- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **Survive** – Experience an event without major loss of hardware. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is knockdown of a global mooring or loss of some part of the mooring resulting in the instrument descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.
- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

2 Specifications

2.1 Measurement

Values provided are threshold unless otherwise stated.

2.1.1 Dissolved oxygen (O_2) concentrations

a) Measurement with unit(s)

Concentration of dissolved oxygen (µmol/kg)

b) Minimum Value

DO2-001 The instrument shall measure dissolved O_2 concentrations in seawater over a range with a minimum value of 0 µmol/kg. <L2-SR-RQ-3128, L4-CG-IP-RQ-187, L4-RSN-IP-RQ-311>

c) Maximum Value

DO2-002 The instrument shall measure dissolved O_2 concentrations in seawater over a range with a maximum value of 500 µmol/kg. <L2-SR-RQ-3128, L4-CG-IP-RQ-187, L4-RSN-IP-RQ-311>

d) Accuracy

DO2-003 The instrument shall measure dissolved O_2 concentrations with an accuracy in the laboratory within ± 2% of the value provided by a Winkler titration of a corresponding water sample. <L2-SR-RQ-3495, L4-CG-IP-RQ-182, L4-RSN-IP-RQ-312>

e) Precision

Not specified.

f) Resolution

DO2-004 The instrument shall measure dissolved O_2 concentrations with a resolution of 1.0 µmol/kg. < L2-SR-RQ-3496, L4-CG-IP-RQ-183, L4-RSN-IP-RQ-313>

g) Drift

DO2-005 The instrument shall measure dissolved O_2 concentrations with an annual drift of less than 10 µmol/kg. < L2-SR-RQ-3498, L4-CG-IP-RQ-348, L4-RSN-IP-RQ-316>

h) Response Times

DO2-006 The instrument shall have a response time of 10 seconds or less for measuring 63% of the changes in values that are greater than or equal to the resolution. <L2-SR-RQ-3799, L4-CG-IP-RQ-561, L4-RSN-IP-RQ-621>

DO2-007 The instrument should have a response time of 10 seconds or less for measuring 95% of the changes in values that are greater than or equal to the resolution. This is an objective. <L2-SR-RQ-3800, L4-CG-IP-RQ-562, L4-RSN-IP-RQ-622>

i) Sampling Frequency

Not specified.

j) Dependencies

Not specified.

2.2 Operational

See platform specifications.

2.3 Mechanical/Physical

See platform specifications.

2.4 Electrical

See platform specifications.

2.5 Data Storage and Processing

See platform specifications.

2.6 Software/Firmware

See platform specifications.

2.7 Platform Interfaces

See platform specifications.

2.8 Compliance

See platform specifications.

2.9 Safety

See platform specifications.

2.10 Shipping and Storage

See platform specifications.

2.11 Identification

See platform specifications.

2.12 Quality

See platform specifications.

3 Appendices

None

SPECIFICATIONS FOR MULTIPLE WAVELENGTH FLUOROMETER/OPTICAL BACKSCATTER INSTRUMENTS ON MOBILE ASSETS AND PROFILERS

Version 2-00
Document Control Number 1331-00003
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Consortium for Ocean Leadership
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University of California, San Diego
University of Washington
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

Document Control Sheet

Version	Date	Description	Originator
0-01	5/18/2010	Derived Profiler specs from general Fluorometer spec.	Rob DelCoco
0-02	5/19/2010	Changed title to include all mobile assets and profilers	Rob DelCoco
0-03	5/21/2010	Revised according to SWG call 5/19 – changed BACK-001 to red wavelength from blue, green, red. Removed sampling rate SAMP-001 from mobile asset spec	Lorraine Brasseur
1-00	5/25/2010	Revised with SE comments, clarified SAMP-001 and SAMP-002; clarified meaning and language regarding excitation and emission wavelengths; added PACK-001	Lorraine Brasseur
1-01	6/09/2010	Partial changes from Tim, Oscar	Lorraine Brasseur
1-02	6/15/2010	Changes from Tim, Oscar, Ed Dever regarding backscatter and number of wavelengths required	Lorraine Brasseur
1-03	6/17/2010	Typos corrected, comments on optical backscatter, coastal and global sampling specifications made explicit – added SAMP-003 for cabled shallow profilers	Ed Dever, Lorraine Brasseur
1-04	6/17/2010	SE suggested wording accepted	Lorraine Brasseur
1-05	01/12/2011	Reformatted to new template	Arthur Salwin (Noblis)
1-06	01/19/2011	Moved linearity spec under accuracy heading for fluorescence. Added accuracy spec for backscatter. Combined lower detection limit with min value of range.	Arthur Salwin (Noblis)

1-07	01/26/2011	Changed document scope and purpose to include profilers and to clean up AUV and glider. Additional changes based on discussions with experts	Lorraine Brasseur
1-08	01/26/2011	Editorial fixes	Arthur Salwin (Noblis)
1-09	02/07/2011	Revised per comments received on ECR #1300-00117 & 1300-00118	Arthur Salwin (Noblis)
1-10	02/10/2011	Minor edits	Rob DelCoco
1-11	02/11/2011	New comment numbers incorporated	Arthur Salwin (Noblis)
2-00	02/15/2011	Approved by Systems Engineer. ECR #1300-000118	Ed Chapman

Signature Page

This document has been reviewed and approved for release to Configuration Management.

OOI Senior Systems Engineer:  .

Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) will lay the foundation for future ocean science observations. OOI will enable powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI will enable multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers will control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

1.2 Document Scope and Purpose

This document provides specifications for instruments on mobile assets and profilers that measure Optical Backscatter, Chlorophyll-a Fluorescence, and CDOM Fluorescence in seawater. These assets include gliders, Autonomous Underwater Vehicles (AUVs), wire-following profilers, and moored shallow/surface piercing profilers.

Gliders are buoyancy-driven, battery powered underwater vehicles that achieve propulsion by changing their volume by pumping to or from an oil-filled bladder. When they dive or rise, the glider's wings achieve lift allowing the glider to fly forward through the water. They can achieve speeds of about one tenth of those of the AUVs or ~25 to 35 cm s^{-1}. At the surface, gliders acquire position information using GPS and transmit data and receive commands via satellite.

AUVs are somewhat like instrumented torpedoes, though optimized for longer life at slower speeds while carrying a sensor payload. Optimum speeds for AUVs used in oceanographic applications are near 1.7 m s^{-1}, while maximum speeds of about 2.5 m s^{-1} may be reached. AUVs have a high payload capacity relative to gliders, and will carry a broad suite of sensors for interdisciplinary

observations. They surface to obtain position fixes using GPS and while at the surface they also enter the OOI communications network using satellite telemetry.

Moored wire-following profilers contain a suite of sensors that are raised and lowered through the water column on a regular basis. These are generally used for deep measurements and profiles that can extent to more than 1000 meters in depth. It is expected that these profilers will move vertically at speeds up to about 0.25 m/s.

Moored shallow/surface piercing profilers are expected to be used in the first 200 meters of the water column on OOI arrays. These profilers will carry a somewhat larger payload than wire-following profilers and can move vertically at speeds up to 0.5 m/s

1.3 Documents

1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, D.C. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/

1.3.2 Applicable

These documents contain requirements and specifications applicable to the instrument specified. The referenced section, requirement, or specification shall be met by the instrument specified herein.

N/A

1.4 Definitions

1.4.1 Glossary and Acronyms

- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measurand (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **AUV** – Autonomous Underwater Vehicle
- **bb(λ)** – Optical Backscatter coefficient at wavelength λ
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **CDOM** – Colored Dissolved Organic Matter
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.

- **OOI** – Ocean Observatories Initiative
- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.
- **Operate** – Correctly performing designed functionality.
- **ppb** – Parts per billion
- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **Survive** – Experience an event without major loss of hardware. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is knockdown of a global mooring or loss of some part of the mooring resulting in the instrument descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.
- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

2 Specifications

2.1 Measurement

MEAS-001 All measurements (optical backscatter, chlorophyll-a fluorescence, and CDOM fluorescence) should be made by the same instrument. This is an objective.

2.1.1 Optical Backscatter

a) Measurement with unit(s)

Optical Backscatter coefficient (bb(λ) m^{-1})

b) Minimum Value

BACK-001 The instrument shall measure optical backscatter over a range with a minimum value of 0.001 bb(λ) m^{-1}. <L2-SR-RQ-3541, L4-CG-IP-RQ-393, L4-RSN-IP-RQ-360>

c) Maximum Value

BACK-002 The instrument shall measure optical backscatter over a range with a maximum value of 0.2 bb(λ) m^{-1}. <L2-SR-RQ-3541, L4-CG-IP-RQ-393, L4-RSN-IP-RQ-360>

d) Accuracy

While accuracy is important to this measurement, a threshold value for accuracy is not provided in this document.

e) Precision

While precision is important to this measurement, a threshold value for precision is not provided in this document.

f) Resolution

While resolution is important to this measurement, a threshold value for resolution is not provided in this document.

g) Drift

While drift is important to this measurement, a threshold value for drift is not provided in this document.

h) Response Times

Not specified

i) Sampling Frequency

BACK-003 The instrument shall be capable of measuring optical backscatter at a sampling frequency of 1 Hz. <L2-SR-RQ-3542, L4-CG-IP-RQ-223, L4-RSN-IP-RQ-361>

j) Dependencies

Not specified

k) Wavelength bands

BACK-004 The instrument shall excite and measure optical backscatter in at least one band in the visible spectrum. <L2-SR-RQ-3787, L4-CG-IP-RQ-551, L4-RSN-IP-RQ-609>

BACK-005 The instrument should excite and measure optical backscatter in two or more bands in the visible spectrum. This is an objective. <L2-SR-RQ-3788, L4-CG-IP-RQ-552, L4-RSN-IP-RQ-610>

BACK-006 The instrument should provide the capability for optical backscatter bands to be user selectable. This is an objective. <L2-SR-RQ-3789, L4-CG-IP-RQ-553, L4-RSN-IP-RQ-611>

2.1.2 Chlorophyll-a Fluorescence

a) Measurement with unit(s)

Chlorophyll-a concentration (µg/L)

b) Minimum Value

CHLO-001 The instrument shall measure chlorophyll-a concentration over a range with a minimum value of 0.03 µg/L for the coastal ocean. <L2-SR-RQ-3554, L4-CG-IP-RQ-217>

CHLO-002 The instrument shall measure chlorophyll-a concentration over a range with a minimum value of 0.01 µg/L for the open ocean. <L2-SR-RQ-3791, L4-CG-IP-RQ-555, L4-RSN-IP-RQ-366>

c) Maximum Value

CHLO-003 The instrument shall measure chlorophyll-a concentration over a range with a maximum value of 50 µg/L for the coastal ocean. <L2-SR-RQ-3554, L4-CG-IP-RQ-217>

CHLO-004 The instrument should measure chlorophyll-a concentration over a range with a maximum value of 125 µg/L for the coastal ocean. This is an objective. <L2-SR-RQ-3790, L4-CG-IP-RQ-554>

CHLO-005 The instrument shall measure chlorophyll-a concentration over a range with a maximum value of 10 µg/L for the open ocean. <L2-SR-RQ-3791, L4-CG-IP-RQ-555, L4-RSN-IP-RQ-366>

d) Accuracy

While accuracy is important to this measurement, a threshold value for accuracy is not provided in this document.

e) Precision

While precision is important to this measurement, a threshold value for precision is not provided in this document.

f) Resolution

While resolution is important to this measurement, a threshold value for resolution is not provided in this document.

g) Drift

While drift is important to this measurement, a threshold value for drift is not provided in this document.

h) Response Times

Not specified

i) Sampling Frequency

CHLO-006 The instrument shall be capable of measuring chlorophyll-a fluorescence at a sampling frequency of 1 Hz. <L2-SR-RQ-3555, L4-CG-IP-RQ-395, L4-RSN-IP-RQ-367>

j) Dependencies

Not specified

k) Wavelengths

CHLO-007 The instrument shall measure fluorescence between 675 and 700 nm induced by excitation between 460 and 490 nm. <L4-CG-IP-RQ-213, L4-RSN-IP-RQ-612>

2.1.3 CDOM Fluorescence

a) Measurement with unit(s)

CDOM concentration (ppb)

b) Minimum Value

CDOM-001 The instrument shall measure CDOM concentration over a range with a minimum value of 0.09 ppb relative to a quinine sulfate standard. <L2-SR-RQ-3557, L4-CG-IP-RQ-219, L4-RSN-IP-RQ-372>

c) Maximum Value

CDOM-002 The instrument shall measure CDOM concentration over a range with a maximum value of 500 ppb relative to a quinine sulfate standard. <L2-SR-RQ-3557, L4-CG-IP-RQ-219, L4-RSN-IP-RQ-372>

d) Accuracy

While accuracy is important to this measurement, a threshold value for accuracy is not provided in this document.

e) Precision

While precision is important to this measurement, a threshold value for precision is not provided in this document.

f) Resolution

While resolution is important to this measurement, a threshold value for resolution is not provided in this document.

g) Drift

While drift is important to this measurement, a threshold value for drift is not provided in this document.

h) Response Times

Not specified

i) Sampling Frequency

CDOM-003 The instrument shall be capable of measuring CDOM fluorescence at a sampling frequency of 1 Hz. <L2-SR-RQ-3558, L4-CG-IP-RQ-397, L4-RSN-IP-RQ-373>

j) Dependencies

Not specified

k) Wavelengths

CDOM-004 The instrument shall measure fluorescence between 450 and 480 nm induced by excitation between 360 and 380 nm. <L4-CG-IP-RQ-214, L4-RSN-IP-RQ-613>

2.2 Operational

See platform specifications.

2.3 Mechanical/Physical

See platform specifications.

2.4 Electrical

See platform specifications.

2.5 Data Storage and Processing

See platform specifications.

2.6 Software/Firmware

See platform specifications.

2.7 Platform Interfaces

See platform specifications.

2.8 Compliance

See platform specifications.

2.9 Safety

See platform specifications.

2.10 Shipping and Storage

See platform specifications.

2.11 Identification

See platform specifications.

2.12 Quality

See platform specifications.

3 Appendices

A-1. Specification Values by the Platform on Which the Instruments are Deployed

The following table provides specifications that vary by the platform on which the instrument is deployed.

Instrument Series	Cabled	Location	# Optical Backscatter Bands	Chlorophyll-a Measurement Required	Chlorophyll-a Range (µg/L)	CDOM Measurement Required	Platforms
Z	C	O	1	Y	0.01 - 10	Y	Shallow water profilers
Y	C	O	1	Y	0.01 - 10	N	Shallow water profilers
X	C	O	1	Y	0.01 - 10	Y	Deep profilers
W	U	C	1	Y	0.03 - 50 (see note 1)	Y	Wire-following profilers, Surface-piercing profilers, Gliders, AUVs
V	C	C	1	Y	0.03 - 50 (see note 1)	Y	Deep profilers, Surface-Piercing profilers
U	U	O	1 (see note 2)	Y	0.01 - 10	N (see note 3)	Wire-following profilers, Surface-piercing profilers, Gliders

Key:

Cabled:
- C denotes platforms attached to the electro-optic cable in the Pacific Northwest (cabled)
- U denotes platforms that have no cable connection to shore for power or data (uncabled)

Location:
- O is open ocean
- C is coastal

Note 1: The objective value for the upper limit of the range is 125 µg/L for Series W and V.

Note 2: Additional optical backscatter bands may be included if they do not impact biofouling mitigation, chlorophyll-a accuracy, size, weight, or power usage.

Note 3: CDOM may be included if it does not impact biofouling mitigation, chlorophyll-a accuracy, size, weight, or power usage.

SPECIFICATIONS FOR PARTIAL PRESSURE OF CARBON DIOXIDE (pCO_2) INSTRUMENTS ON MOBILE ASSETS AND PROFILERS

Version 1-00
Document Control Number 1331-00012
2010-11-16

Consortium for Ocean Leadership
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in Cooperation with

University of California, San Diego
University of Washington
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

Document Control Sheet

Version	Date	Description	Originator
0-01	05/10/2010	Initial Draft	Thien V. Dinh
0-02	05/24/2010	Extracted performance specs from earlier version	Rob DelCoco
0-03	08/23/2010	Reformatted per revised template; new document control number	Arthur Salwin (Noblis)
0-04	10/07/2010	Revised following 5-day review period of corresponding fixed platform specifications.	Arthur Salwin (Noblis)
0-05	10/13/2010	Established consistency for pCO_2 Revised glossary Reference platform specs Added “not specified” to measurement parameters	Arthur Salwin (Noblis)
0-06	11/04/2010	Replaced placeholder requirements references.	Arthur Salwin (Noblis)
0-07	11/16/2010	Addressed 5-day review comments	Arthur Salwin (Noblis)
1-00	11/16/2010	S.E. approval – no other changes	Arthur Salwin (Noblis)

Signature Page

This document has been reviewed and approved for release to Configuration Management.

OOI Senior Systems Engineer: 

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Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) will lay the foundation for future ocean science observations. OOI will enable powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI will enable multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers will control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

1.2 Document Scope and Purpose

This document provides specifications for instruments on mobile assets and profilers that measure the partial pressure of carbon dioxide (CO_2) in water. Mobile assets for OOI include buoyancy-driven gliders and propeller-driven Autonomous Underwater Vehicles (AUVs).

Gliders are underwater autonomous vehicles that profile vertically by controlling buoyancy and moving horizontally on wings. They will be employed for two general purposes: providing horizontal context to horizontally fixed platforms, and communicating with subsurface instruments for relaying their data to shore. The buoyancy-driven, battery powered gliders change their volume by pumping to or from an oil-filled bladder; when they dive or rise; the glider's wings achieve lift allowing the glider to fly forward through the water. They can achieve speeds of about one tenth of those of the AUVs or ~25 to 35 cm s^{-1}. At the surface, gliders acquire position information using GPS and transmit data and receive commands via satellite.

AUVs are somewhat like instrumented torpedoes, though optimized for longer life at slower speeds while carrying a sensor payload. Optimum speeds for AUVs used in oceanographic applications are near 1.7 m s^{-1}, while maximum speeds of about 2.5 m s^{-1} may be reached. AUVs have a high

payload capacity relative to gliders, and will carry a broad suite of sensors for interdisciplinary observations. They surface to obtain position fixes using GPS and while at the surface they also enter the OOI communications network using satellite telemetry. AUVs can run continuous missions of up to several days and are small enough to be deployed and recovered from a small boat.

Moored profilers contain a suite of sensors that are raised and lowered through the water column on a regular basis. The profiler body may travel through the water column using wire-following for deep measurements or winched technique for surface piercing measurements.

1.3 Documents

1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, D.C. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/

1.3.2 Applicable

These documents contain requirements and specifications applicable to the instrument specified. The referenced section, requirement, or specification shall be met by the instrument specified herein.

N/A

1.4 Definitions

1.4.1 Glossary and Acronyms

- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measurand (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.
- **OOI** – Ocean Observatories Initiative
- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.
- **Operate** – Correctly performing designed functionality.
- **pCO_2** – Partial Pressure of Carbon Dioxide

- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **Survive** – Experience an event without major loss of hardware. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is knockdown of a global mooring or loss of some part of the mooring resulting in the instrument descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.
- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

2 Specifications

2.1 Measurement

Values provided are threshold unless otherwise stated.

2.1.1 Partial Pressure of Carbon Dioxide (pCO_2) in Water

a) Measurement with unit(s)

Partial pressure of carbon dioxide in water (µatm)

b) Minimum Value

PCO2-001 The instrument shall measure pCO_2 in water over a range with a minimum value of 100 µatm. <L2-SR-RQ-3505, L4-CG-IP-RQ-504, L4-RSN-IP-RQ-323>

c) Maximum Value

PCO2-002 The instrument shall measure pCO_2 in water over a range with a maximum value of 2,000 µatm. <L2-SR-RQ-3505, L4-CG-IP-RQ-504, L4-RSN-IP-RQ-323>

d) Accuracy

PCO2-003 The instrument shall measure pCO_2 in water with an accuracy within ±4 µatm of the true value for concentrations ≤400 µatm. <L2-SR-RQ-3712, L4-CG-IP-RQ-505, L4-RSN-IP-RQ-559>

PCO2-004 The instrument shall measure pCO_2 in water with an accuracy within ±1% of the true value for concentrations >400 µatm. <L2-SR-RQ-3713, L4-CG-IP-RQ-506, L4-RSN-IP-RQ-560>

PCO2-005 The instrument should measure pCO_2 in water with an accuracy within ±2 µatm of the true value for concentrations ≤400 µatm. This is an objective. <L2-SR-RQ-3714, L4-CG-IP-RQ-507, L4-RSN-IP-RQ-561>

PCO2-006 The instrument should measure pCO_2 in water with an accuracy within ±0.5% of the true value for concentrations >400 µatm. This is an objective. <L2-SR-RQ-3715, L4-CG-IP-RQ-508, L4-RSN-IP-RQ-562>

e) Precision

PCO2-007 For concentrations ≤400 µatm, the instrument shall measure pCO_2 in water with a precision of ±2 µatm. <L2-SR-RQ-3716, L4-CG-IP-RQ-509, L4-RSN-IP-RQ-563>

PCO2-008 For concentrations >400 µatm, the instrument shall measure pCO_2 in water with a precision of ±0.50%. <L2-SR-RQ-3717, L4-CG-IP-RQ510, L4-RSN-IP-RQ-564>

PCO2-009 For concentrations ≤400 µatm, the instrument should measure pCO_2 in water with a precision of ±1 µatm. This is an objective. <L2-SR-RQ-3718, L4-CG-IP-RQ-511, L4-RSN-IP-RQ-565>

PCO2-010 For concentrations >400 µatm, the instrument should measure pCO_2 in water with a precision of ±0.25%. This is an objective. <L2-SR-RQ-3719, L4-CG-IP-RQ-512, L4-RSN-IP-RQ-566>

f) Resolution

Not specified.

g) Drift

Not specified.

h) Response Times

Not specified.

i) Sampling Frequency

Not specified.

j) Dependencies

Not specified.

2.2 Operational

See platform specifications for operational depth range and other operational specifications.

2.3 Mechanical/Physical

See platform specifications.

2.4 Electrical

See platform specifications.

2.5 Data Storage and Processing

See platform specifications.

2.6 Software/Firmware

See platform specifications.

2.7 Platform Interfaces

See platform specifications.

2.8 Compliance

See platform specifications.

2.9 Safety

See platform specifications.

2.10 Shipping and Storage

See platform specifications.

2.11 Identification

See platform specifications.

2.12 Quality

See platform specifications.

3 Documentation

See the RFP for documentation that the vendor shall be required to supply.

4 Appendices

None

SPECIFICATIONS FOR SPECTRAL IRRADIANCE INSTRUMENTS ON MOBILE ASSETS AND PROFILERS (MAP)

Version 1-00
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Consortium for Ocean Leadership
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Document Control Sheet

Version	Date	Description	Originator
0-01	05/17/2010	Derived Glider specs from general SPKIR spec	Rob DelCoco
0-02	05/24/2010	Changes to title, numbering, and removal of synoptic temperature reference	Rob DelCoco
0-03	07/05/2010	Formatting edits and name change correction	Lorraine Brasseur
0-04	08/27/2010	Reformatted per spec template v1-01 and changed document control number accordingly. Highlighted fixed platform common spec requirements for consideration.	Arthur Salwin (Noblis)
0-05	08/31/2010	Revised per meeting with subject matter experts. Revised fixed platform common spec requirements for consideration per v-0-03 of that spec.	Arthur Salwin (Noblis)
0-06	10/13/2010	SWG inputs. Reverted document number. Updated glossary. Reference platform specs. Revised per 5-day review of corresponding fixed platform spec. Clarified units.	Arthur Salwin (Noblis)
0-07	10/19/2010	Added “not specified” and references to platform specifications	Arthur Salwin (Noblis)
0-08	11/01/2010	Changed “within a wavelength range” to “over a wavelength range”. Changed resolution to precision.	Arthur Salwin (Noblis)
0-09	11/04/2010	Edited spec numbers	Arthur Salwin (Noblis)
0-10	11/16/2010	Addressed comments from 5-day review.	Arthur Salwin (Noblis)
0-11	12/09/2010	Referenced new requirements for precision and wavelength range	Arthur Salwin (Noblis)
1-00	12/10/2010	Initial Release	Ed Chapman

Signature Page

This document has been reviewed and approved for release to Configuration Management.

OOI Senior Systems Engineer:  .

Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) will lay the foundation for future ocean science observations. OOI will enable powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI will enable multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers will control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

1.2 Document Scope and Purpose

This document contains the specifications for Spectral Irradiance (SPKIR) instruments that will be deployed on mobile assets and profilers to measure downwelling spectral irradiance. Mobile assets for OOI include buoyancy-driven gliders and propeller-driven Autonomous Underwater Vehicles (AUVs).

Gliders are underwater autonomous vehicles that profile vertically by controlling buoyancy and moving horizontally on wings. They will be employed for two general purposes: providing horizontal context to horizontally fixed platforms, and communicating with subsurface instruments for relaying their data to shore. The buoyancy-driven, battery powered gliders change their volume by pumping to or from an oil-filled bladder; when they dive or rise; the glider's wings achieve lift allowing the glider to fly forward through the water. They can achieve speeds of about one tenth of those of the AUVs or ~25 to 35 cm s^{-1}. At the surface, gliders acquire position information using GPS and transmit data and receive commands via satellite.

AUVs are somewhat like instrumented torpedoes, though optimized for longer life at slower speeds while carrying a sensor payload. Optimum speeds for AUVs used in oceanographic applications

are near 1.7 m s^{-1}, while maximum speeds of about 2.5 m s^{-1} may be reached. AUVs have a high payload capacity relative to gliders, and will carry a broad suite of sensors for interdisciplinary observations. They surface to obtain position fixes using GPS and while at the surface they also enter the OOI communications network using satellite telemetry. AUVs can run continuous missions of up to several days and are small enough to be deployed and recovered from a small boat.

Moored profilers contain a suite of sensors that are raised and lowered through the water column on a regular basis. The profiler body may travel through the water column using wire-following for deep measurements or winched technique for surface piercing measurements.

1.3 Documents

1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, D.C. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/

1.3.2 Applicable

These documents contain requirements and specifications applicable to the instrument specified. The referenced section, requirement, or specification shall be met by the instrument specified herein.

N/A

1.4 Definitions

1.4.1 Glossary and Acronyms

- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measurand (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.
- **MAP** – Mobile Assets and Profilers
- **OOI** – Ocean Observatories Initiative
- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.

- **Operate** – Correctly performing designed functionality.
- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **SPKIR** – Spectral irradiance
- **Survive** – Experience an event without major loss of hardware. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is knockdown of a global mooring or loss of some part of the mooring resulting in the instrument descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.
- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

2 Specifications

2.1 Measurement

Values provided are threshold unless otherwise stated.

2.1.1 Downwelling spectral irradiance

a) Measurement with unit(s)

Downwelling spectral irradiance (µmol photons m^{-2} s^{-1})

b) Minimum Value

SPKI-001 The instrument shall measure downwelling spectral irradiance over a range with a minimum value of 0.1 µmol photons m^{-2} s^{-1} across the

entire wavelength range specified in section 2.1.1k. <L2-SR-RQ-3528, L4-CG-IP-RQ-377, L4-RSN-IP-RQ-494>

c) Maximum Value

SPKI-002 The instrument shall measure downwelling spectral irradiance over a range with a maximum value of 2000 µmol photons m^{-2} s^{-1} across the entire wavelength range specified in section 2.1.1k. <L2-SR-RQ-3528, L4-CG-IP-RQ-377, L4-RSN-IP-RQ-494>

d) Accuracy

SPKI-003 The instrument shall measure downwelling spectral irradiance with an accuracy within ±5% of the true value. <L2-SR-RQ-3527, L4-CG-IP-RQ-374, L4-RSN-IP-RQ-493>

e) Precision

SPKI-004 The instrument shall measure downwelling spectral irradiance with a precision of 0.01 µmol photons m^{-2} s^{-1}. <L2-SR-RQ-3781, L4-CG-IP-RQ-527, L4-RSN-IP-RQ-595>

f) Resolution

Not specified.

g) Drift

Not specified.

h) Response Times

Not specified.

i) Sampling Frequency

Not specified.

j) Dependencies

Not specified.

k) Wavelength range

SPKI-005 The instrument shall measure downwelling spectral irradiance over the wavelength range of 380 nm to 720 nm. <L2-SR-RQ-3526, L4-CG-IP-RQ-206, L4-RSN-IP-RQ-490>

SPKI-006 The instrument should measure downwelling spectral irradiance over the wavelength range of 380 nm to 750 nm. This is an objective. <L2-SR-RQ-3780, L4-CG-IP-RQ-526, L4-RSN-IP-RQ-593>

l) Number of bands

SPKI-007 The instrument shall measure downwelling spectral irradiance in no fewer than 7 bands over the wavelength range specified in section 2.1.1.k. <L2-SR-RQ-3668, L4-CG-IP-RQ-373, L4-RSN-IP-RQ-491>

m) Spectral Bandwidth

SPKI-008 The instrument shall have spectral bandwidths of no more than 20 nm. <L2-SR-RQ-3669, L4-CG-IP-RQ-207, L4-RSN-IP-RQ-492>

2.2 Operational

See Platform Specifications.

2.3 Mechanical/Physical

See Platform Specifications.

2.4 Electrical

See Platform Specifications.

2.5 Data Storage and Processing

See Platform Specifications.

2.6 Software/Firmware

See Platform Specifications.

2.7 Platform Interfaces

See Platform Specifications.

2.8 Compliance

See Platform Specifications.

2.9 Safety

See Platform Specifications.

2.10 Shipping and Storage

See Platform Specifications.

2.11 Identification

See Platform Specifications.

2.12 Quality

See Platform Specifications.

3 Documentation

See the RFP for documentation that the vendor shall be required to supply.

4 Appendices

None

SPECIFICATIONS FOR OPTICAL ATTENUATION AND ABSORPTION INSTRUMENTS ON MOBILE ASSETS AND PROFILERS (MAP)

Version 1-00
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Oregon State University
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Document Control Sheet

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0-01	05/10/2010	Initial Draft	Thien V. Dinh
0-02	05/24/2010	Extracted performance specs from earlier version	Rob DelCoco
0-03	08/25/2010	Reformatted per revised template; new document control number	Arthur Salwin (Noblis)
0-04	10/06/2010	Reverted to original document number. Revised definitions. Revised precision, operational depth, and wavelength range.	Arthur Salwin (Noblis)
0-05	10/26/2010	Changed “within a wavelength range” to “over a wavelength range”. Referenced platform specifications in lieu of specifying operational depth range. Minor editorial fixes.	Arthur Salwin (Noblis)
0-06	11/03/2010	Revised language per approved ECR. Added references to platform specs.	Arthur Salwin (Noblis)
0-07	11/16/2010	Addressed 5-day review comments. Referenced new requirements.	Arthur Salwin (Noblis)
1-00	11/16/2010	S.E. approval – no other changes	Arthur Salwin (Noblis)

Signature Page

This document has been reviewed and approved for release to Configuration Management.

OOI Senior Systems Engineer:_____

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Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) will lay the foundation for future ocean science observations. OOI will enable powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI will enable multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers will control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

1.2 Document Scope and Purpose

This document provides specifications for instruments on mobile assets and profilers that measure optical attenuation and absorption. Mobile assets for OOI include buoyancy-driven gliders and propeller-driven Autonomous Underwater Vehicles (AUVs).

Gliders are underwater autonomous vehicles that profile vertically by controlling buoyancy and moving horizontally on wings. They will be employed for two general purposes: providing horizontal context to horizontally fixed platforms, and communicating with subsurface instruments for relaying their data to shore. The buoyancy-driven, battery powered gliders change their volume by pumping to or from an oil-filled bladder; when they dive or rise; the glider's wings achieve lift allowing the glider to fly forward through the water. They can achieve speeds of about one tenth of those of the AUVs or ~25 to 35 cm s^{-1}. At the surface, gliders acquire position information using GPS and transmit data and receive commands via satellite.

AUVs are somewhat like instrumented torpedoes, though optimized for longer life at slower speeds while carrying a sensor payload. Optimum speeds for AUVs used in oceanographic applications are near 1.7 m s^{-1}, while maximum speeds of about 2.5 m s^{-1} may be reached. AUVs have a high

payload capacity relative to gliders, and will carry a broad suite of sensors for interdisciplinary observations. They surface to obtain position fixes using GPS and while at the surface they also enter the OOI communications network using satellite telemetry. AUVs can run continuous missions of up to several days and are small enough to be deployed and recovered from a small boat.

Moored profilers contain a suite of sensors that are raised and lowered through the water column on a regular basis. The profiler body may travel through the water column using wire-following for deep measurements or winched technique for surface piercing measurements.

1.3 Documents

1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, D.C. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/

1.3.2 Applicable

These documents contain requirements and specifications applicable to the instrument specified. The referenced section, requirement, or specification shall be met by the instrument specified herein.

N/A

1.4 Definitions

1.4.1 Glossary and Acronyms

- **a(λ)** – Absorption coefficient at wavelength λ
- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measurand (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **c(λ)** – Attenuation coefficient at wavelength λ
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.
- **OOI** – Ocean Observatories Initiative
- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.

- **Operate** – Correctly performing designed functionality.
- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **Survive** – Experience an event without major loss of hardware. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is knockdown of a global mooring or loss of some part of the mooring resulting in the instrument descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.
- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

2 Specifications

2.1 Measurement

Values provided are threshold unless otherwise stated.

2.1.1 Optical Absorption

a) Measurement with unit(s)

Spectral absorption (a(λ)/m)

b) Minimum Value

ABSO-001 The instrument shall measure spectral absorption over a range with a minimum value of 0.05 a(λ)/m.
<L2-SR-RQ-3533, L4-CG-IP-RQ-228, L4-RSN-IP-RQ-348>

c) Maximum Value

ABSO-002 The instrument shall measure spectral absorption over a range with a maximum value of 8 a(λ)/m. <L2-SR-RQ-3533, L4-CG-IP-RQ-228, L4-RSN-IP-RQ-348>

d) Accuracy

ABSO-003 The instrument shall measure spectral absorption with an accuracy within ±0.01 a(λ)/m of the true value. <L2-SR-RQ-3532, L4-CG-IP-RQ-226, L4-RSN-IP-RQ-347>

e) Precision

ABSO-004 The instrument shall measure spectral absorption with a precision of 0.005 a(λ)/m. <L2-SR-RQ-3742, L4-CG-IP-RQ-514, L4-RSN-IP-RQ-567>

ABSO-005 The instrument should measure spectral absorption with a precision of 10^{-3} a(λ)/m. This is an objective. <L2-SR-RQ-3743, L4-CG-IP-RQ-515, L4-RSN-IP-RQ-568>

f) Resolution

Not specified.

g) Drift

Not specified.

h) Response Times

Not specified.

i) Sampling Frequency

Not specified.

j) Dependencies

Not specified.

k) Wavelength range

ABSO-006 The instrument shall measure spectral absorption over the wavelength range of 400 nm to 720 nm. <L2-SR-RQ-3744, L4-CG-IP-RQ-516, L4-RSN-IP-RQ-569>

ABSO-007 The instrument should measure spectral absorption over the wavelength range of 400 nm to 750 nm. This is an objective. <L2-SR-RQ-3745, L4-CG-IP-RQ-517, L4-RSN-IP-RQ-570>

l) Number of bands

ABSO-008 The instrument shall measure spectral absorption in no fewer than 7 bands over the wavelength range specified in 2.1.1.k. <L2-SR-RQ-3746, L4-CG-IP-RQ-518, L4-RSN-IP-RQ-571>

m) Spectral Bandwidth

ABSO-009 The instrument shall have spectral bandwidths of no more than 20 nm. <L2-SR-RQ-3747, L4-CG-IP-RQ-519, L4-RSN-IP-RQ-572>

2.1.2 Optical Attenuation

a) Measurement with unit(s)

Spectral attenuation (c(λ)/m)

b) Minimum Value

ATTE-001 The instrument shall measure spectral attenuation over a range with a minimum value of 0.05 c(λ)/m.
<L2-SR-RQ-3537, L4-CG-IP-RQ-401, L4-RSN-IP-RQ-354>

c) Maximum Value

ATTE-002 The instrument shall measure spectral attenuation over a range with a maximum value of 15 c(λ)/m.
<L2-SR-RQ-3537, L4-CG-IP-RQ-401, L4-RSN-IP-RQ-354>

d) Accuracy

ATTE-003 The instrument shall measure spectral attenuation with an accuracy within ±0.01 c(λ)/m of the true value. <L2-SR-RQ-3536, L4-CG-IP-RQ-399, L4-RSN-IP-RQ-353>

e) Precision

ATTE-004 The instrument shall measure spectral attenuation with a precision of 0.005 c(λ)/m. <L2-SR-RQ-3748, L4-CG-IP-RQ-520, L4-RSN-IP-RQ-573>

ATTE-005 The instrument should measure spectral attenuation with a precision of 10^{-3} c(λ)/m. This is an objective. <L2-SR-RQ-3749, L4-CG-IP-RQ-521, L4-RSN-IP-RQ-574>

f) Resolution

Not specified.

g) Drift

Not specified.

h) Response Times

Not specified.

i) Sampling Frequency

Not specified.

j) Dependencies

Not specified.

k) Wavelength range

ATTE-006 The instrument shall measure spectral attenuation over the wavelength range of 400 nm to 720 nm. <L2-SR-RQ-3750, L4-CG-IP-RQ-522, L4-RSN-IP-RQ-575>

ATTE-007 The instrument should measure spectral attenuation over the wavelength range of 400 nm to 750 nm. This is an objective. <L2-SR-RQ-3751, L4-CG-IP-RQ-523, L4-RSN-IP-RQ-576>

l) Number of bands

ATTE-008 The instrument shall measure spectral attenuation in no fewer than 7 bands over the wavelength range specified in 2.1.2.k. <L2-SR-RQ-3752, L4-CG-IP-RQ-524, L4-RSN-IP-RQ-577>

m) Spectral Bandwidth

ATTE-009 The instrument shall have spectral bandwidths of no more than 20 nm. <L2-SR-RQ-3753, L4-CG-IP-RQ-525, L4-RSN-IP-RQ-578>

2.2 Operational

See platform specifications.

2.3 Mechanical/Physical

See platform specifications.

2.4 Electrical

See platform specifications.

2.5 Data Storage and Processing

See platform specifications.

2.6 Software/Firmware

See platform specifications.

2.7 Platform Interfaces

See platform specifications.

2.8 Compliance

See platform specifications.

2.9 Safety

See platform specifications.

2.10 Shipping and Storage

See platform specifications.

2.11 Identification

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2.12 Quality

See platform specifications.

3 Documentation

See the RFP for documentation that the vendor shall be required to supply.

4 Appendices

None

SPECIFICATIONS FOR NITRATE INSTRUMENTS ON PROFILERS

Version 1-00
Document Control Number 1331-00014
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Consortium for Ocean Leadership
1201 New York Ave NW, 4th Floor, Washington DC 20005
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in Cooperation with

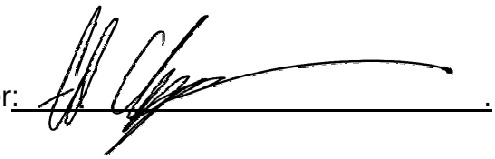
University of California, San Diego
University of Washington
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

Document Control Sheet

Version	Date	Description	Originator
0-01	2010/05/26	Initial spec from requirements	Lorraine Brasseur
0-02	2010/07/08	With comments from K Daly in yellow highlights	Lorraine Brasseur
0-03	2010/08/26	Revised based on SWG meeting 8/11/2010	Wade Smith (Noblis)
0-04	2011/01/07	Specifications placed on new template	Noblis
0-05	2011/01/14	Specifications corrected to reflect application only on profilers and not AUV or Gliders	Noblis
0-06	2011/02/01	Incorporated adjudicated 5-day review comments; Specifications corrected to reflect application on CG profilers only	Noblis
0-07	2011/02/03	Minor changes to document title and document scope wording	Noblis
1-00	2011-03-02	Initial Release	Ed Chapman

Signature Page

This document has been reviewed and approved for release to Configuration Management.

OOI Senior Systems Engineer:  .

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2 Specifications

2.1 Measurement

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2.1.1 Nitrate in seawater (NO_3^-)

a) Measurement with unit(s)

Dissolved Nitrate (micromolar; µM)

b) Minimum Value

NITR-001 The instrument shall measure dissolved nitrate (NO_3^-) in seawater over a range with a minimum value of 0.5 µM <L4-CG-IP-RQ-234, L2-SR-RQ-3130>

NITR-002 The instrument should measure dissolved nitrate (NO_3^-) in seawater over a range with a minimum value of 0.03 µM. This is an objective. <L4-CG-IP-RQ-556, L4-RSN-IP-RQ-614, L2-SR-RQ-3795>

c) Maximum Value

NITR-003 The instrument shall measure dissolved nitrate (NO_3^-) in seawater over a range with a maximum value of 50 µM <L4-CG-IP-RQ-234, L2-SR-RQ-3130>

d) Accuracy

NITR-004 The instrument shall measure dissolved nitrate (NO_3^-) in seawater with an accuracy of ± 2 µM for nitrate concentrations below 20 µM <L4-CG-IP-RQ-233, L2-SR-RQ-3508>

NITR-005 The instrument should measure dissolved nitrate (NO_3^-) in seawater with an accuracy of ± 0.05 µM for nitrate concentrations below 20 µM. This is an objective. <L4-CG-IP-RQ-557, L4-RSN-IP-RQ-615, L2-SR-RQ-3796>

NITR-006 The instrument shall measure dissolved nitrate (NO_3^-) in seawater with an accuracy of ± 10% for nitrate concentrations at or above 20 µM <L4-CG-IP-RQ-403, L2-SR-RQ-3509>

e) Precision

NITR-007 The instrument shall measure dissolved nitrate (NO_3^-) in seawater with a precision of ± 2% of the measured value. <L4-RSN-IP-RQ-330, L2-SR-RQ-3510, L4-CG-IP-RQ-558>

f) Resolution

Not specified

g) Drift

NITR-008 The instrument shall measure dissolved nitrate (NO_3^-) in seawater with a drift of no greater than 4 µM over a deployment of seven months <L4-CG-IP-RQ-404, L2-SR-RQ-3514>

h) Response Times

Not specified

i) Sampling Frequency

NITR -009 The instrument shall be capable of measuring dissolved nitrate at a sampling frequency of 1Hz <L4-CG-IP-RQ-239, L2-SR-RQ-3511>

j) Dependencies

Not specified.

2.2 Operational

See platform specifications.

2.3 Mechanical/Physical

See platform specifications.

2.4 Electrical

See platform specifications.

2.5 Data Storage and Processing

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None