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

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Document Control Sheet

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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)
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Signature Page

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

OOI Senior Systems Engineer: 

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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