Test Plan: Coastal Glider PVT (CG-VE-3098)

Control Number: 3167-10000
Version: 2-00
Date: 14 October, 2011

Coastal and Global Scale Nodes
Ocean Observatories Initiative
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

Revision History

Version	Description	Originator	ECR No.	Release Date
1-00	Initial Draft	D Neiman	1303-00361	01 August 2011
2-00	Verification method updates, typo fixes	D. Neiman	1303-00486	28 September 2011

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Scope

This test plan applies to the Product Verification Test (PVT) of the Slocum G2 glider platforms acquired as the Coastal Glider (200m,1000m) test article for the Coastal and Global Scale Nodes (CGSN) implementing organization (IO) of the Ocean Observatories Initiative (OOI) coastal arrays (Endurance and Pioneer). This plan describes the verification activities to be conducted consisting of a combination of vendor testing and CGSN-conducted field test and functional demonstrations. Integration of the platform by the vendor occurs before this PVT begins. Other necessary preconditions for the PVT are:
1) The glider will have passed all vendor FAT tests and be accepted by CGSN.
2) A Test Readiness Review (TRR) will have been successfully completed.

1.2 Product Verification Test Purpose

The purpose of the PVT is to demonstrate compliance to the CGSN Level 4 (L4), applicable Level 3 (L3) requirements and the associated specifications for the test article. Successful completion of this PVT is a precondition for the Production Readiness Review (PRR) (currently scheduled for 2/2012).

1.3 Slocum Electric Glider Model 2 (S-G2) Overview

The Slocum Electric Glider 2 (S-G2) (Figure 1) is a type of autonomous submarine that uses changes in buoyancy as a propulsion mechanism similar to an aerial glider's use of dives and thermals. The S-G2 is a Commercial Off-The-Shelf (COTS) glider platform, and the company currently known as Teledyne-Webb Research (TWR) has produced approximately 200 total of S-G2 and its predecessor models of glider. An overview description of the asset is given below:

Table 1-1: Test Article Overview

Asset	Description	Serial No.
Slocum Electric Glider 2	CGSN PN 3304-00003-00001 (200m engine) CGSN PN 3304-00003-00002 (1000m engine)	247
Power	Lithium Primary Batteries (78 DD) Lithium emergency pack (3 C cell)	
Primary Scientific Sensors	Seabird Slocum Glider Payload CTD (pumped) Aandera Optode 3830 WET Labs ECO triplet RDI Explorer SVDVL Biospherical QSP2100 PAR	0073 1407 FLBBCDSLK-2110 2126924 50136
Telemetry	Iridium RUDICS, backup to analog modem receiver Freewave (Line-of-sight only)	
Emergency recovery	ARGOS	

Sensor serial numbers will be listed in the predeployment quick look test report for the as-tested glider, document number 3167-17000. The S-G2 has successfully carried sensors suited to all the science requirements for the Coastal Gliders, and has carried all the sensor types specified by CGSN except for the Biospherical Scalar PAR. All integration up to the platform level has been performed by TWR. CGSN will use two variants of the buoyancy engine on the Coastal Gliders, one optimized for rapid response with a maximum depth capability of 200m and the other optimized for 1000m depth but with slower response. Buoyancy engines are considered completely modular, with plug-in replacement. Both buoyancy engines have a production and reliability record, but the demonstration of the performance of the 1000m engine in the Endurance and Pioneer array regions

(Figures 2 and 3) is one of the primary objectives of this test. All Coastal Gliders will carry the same scientific sensors, and the only engineering sensor differences are related to the buoyancy engine used in a given deployment. Unique to the S-G2s deployed by OOI will be sensor load and the routine extended (2-3 month) missions. Missions of this length have been projected by TWR to be within the capability of the lithium battery packs now being deployed by some S-G2 users. The relatively heavy sensor load requires an extension to the glider design incorporating two science bay hull sections. The OOI glider bays will include a short front bay dedicated to the Acoustic Doppler Current Profiler (ADCP) and a standard-length bay with the Conductivity-Temperature-Depth (CTD), bio-optical, and Photosynthetically-Available Radiation (PAR) sensors. The black color of the payload bays is not standard for Slocum gliders, and was selected to minimize reflection from the hull to the PAR. This change is not expected to create any risk to the glider or its ability to conduct measurements. The expected effect on glider performance relative to the more-common single bay Slocum is that, as the water volume at full-stroke of the buoyancy engine relative to the total glider volume is less, the forward speed at a given dive angle will also be less than the single bay type. An image of the two-bay S-G2 in OOI configuration is shown below:

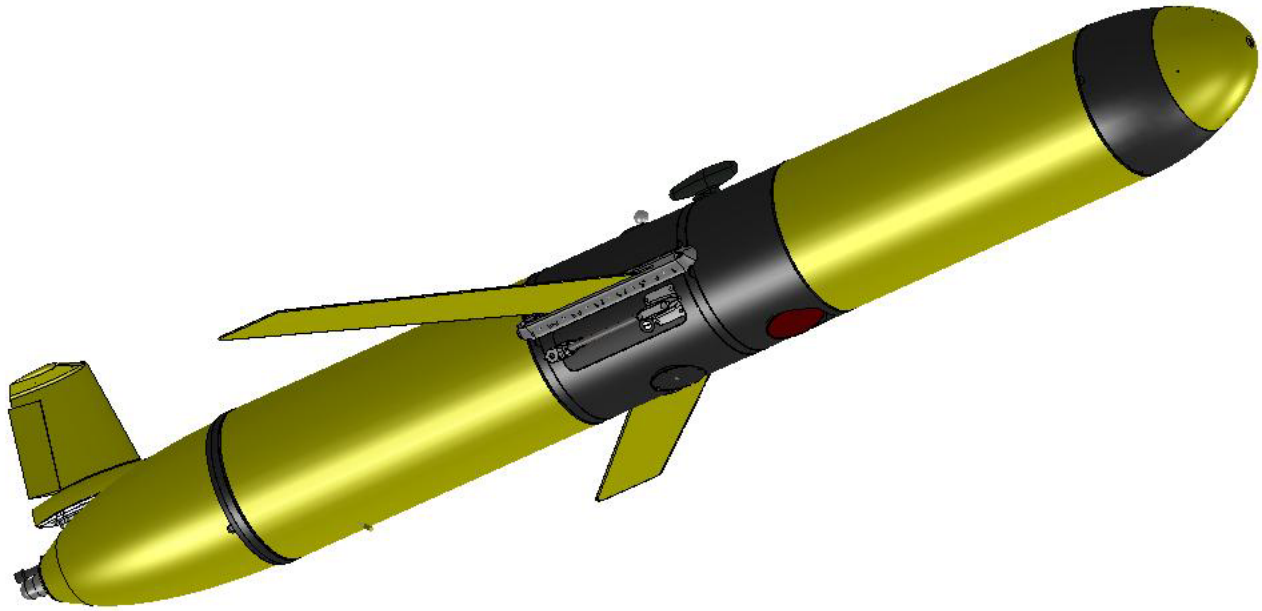

Figure 1: Two-bay S-G2 in OOI Coastal Glider configuration.
The hull section to which the wings attach and the section immediately forward of it house the science sensors. The yellow forward section of the glider nose is an ejectable float that spools out line for recovery. The recovery nose will be fitted to the first-article glider for OOI evaluation.

1.4 Roles and Responsibilities

Table 1-2: Coastal Glider PVT Roles and Responsibilities

Organization	Roles and Responsibilities
WHOI – Woods Hole Oceanographic Institution	Lead CGSN organization and supporting organization for Coastal Glider PVT. Responsible for supporting test preparations and at-sea operations for east coast sea trials
OSU – Oregon State University	Leading organization for Coastal Glider PVT. Responsible for overall coordination with other organizations. Responsible for supporting test planning and preparations, west coast at-sea trials, and post-test analysis efforts. Responsible for post-test analyses and final test reporting.

Organization	Roles and Responsibilities
Teledyne-Webb Research	Manufacturer, Responsible for provision of test article with applicable FATs, S-G2 specific training needed for deployment and recovery, and glider piloting during sea trials. Supplies all instrument calibration and other supporting documentation for sensors.
Raytheon Company (WHOI subcontract)	Systems engineering consultant. Responsible for Overall planning support including test documentation and process development.

1.5 Reference Documents

The following documents are referenced in this PVT. The latest revision of each applies unless noted in the text.

Table 1-3: Referenced Documents

Document Identifier	Document Title
3101-00033	CGSN Integration and Verification Plan (IVP)
TWR # 237-003	TWR Slocum Electric Glider Quality Plan
TWR Part# 4343 Rev.1	TWR Slocum Glider Operator's Manual
3304-00003	Coastal Glider Specifications
L3 CG System Requirements	DOORS L3 requirements, Version 2.11 CG-CCB-2011-08-24
L4 CG Glider Requirements	DOORS L4 requirements, Version 2.10 CG-CCB-2011-09-21
L4 CG Instrument Package Requirements	DOORS L4 requirements, Version 2.21 CG-CCB-2011-08-24

1.6 Definitions & Acronyms

The following acronyms are used in this document:

Table 1-4: Acronym Definitions

Acronym	Definition
ADCP	Acoustic Doppler Current Profiler
CDOM	Colored Dissolved Organic Matter
CGSN	Coastal and Global Scale Nodes
CI	Cyberinfrastructure
COTS	Commercial Off-The-Shelf
CTD	Conductivity-Temperature-Depth
DO	Dissolved Oxygen
FAT	Factory Acceptance Test
GPS	Global Positioning System
IO	Implementing Organization
IVP	Integration and Verification Plan
LOS	Line Of Sight
OOC	Ocean Observing Center (at OSU)
OOI	Ocean Observatories Initiative
OSU	Oregon State University
PAR	Photosynthetically-Available Radiation
PRR	Production Readiness Review

Acronym	Definition
PVT	Product Verification Test
RUDICS	Router-Based Unrestricted Digital Interworking Connectivity Solution
S-G2	Slocum Electric Glider Model 2
THREDDS	Thematic Realtime Environmental Distributed Data Services
TWR	Teledyne Webb Research
UTC	Coordinated Universal Time
WHOI	Woods Hole Oceanographic Institution

The following terminology is used in this document:

Table 1-5: Definition of Terminology

Term	Definition
Course	The set of waypoints that define the glider's intended movements, and the path the glider follows as it attempts to reach those waypoints.
Deployment	The time between placing a glider in the ocean for testing or product-data collection and the time it is retrieved from the ocean.
Mission	The combined set of waypoints and sensor settings controlling the glider's motion, data collection and data telemetry. A glider can change missions during a deployment in response to shore commands or glider conditions.
Pilot	A human (or computer routine) that issues mission or other commands to the glider
Waypoint	A set of coordinates given to the glider by the glider pilot as a location target during a mission.

2 Test Approach

The primary test approaches to be used with the first-article OOI S-G2 will include inspection of the test article and its supporting documentation, and sea trial demonstrations of the test article off the coast of New England in the Pioneer Array region and off the coast of Oregon in the Endurance array region.

2.1 Test Objectives

The objective of the test is verification that the first-article glider meets the specifications described in document 3304-00003 and the applicable OOI requirements in the OOI DOORS database.

2.2 Test Environments and Configurations

For this PVT, the glider will be fitted with a 200m depth engine for inspection and bench tests and a 1000m depth engine for inspection and dry/wet tests. The glider will be inspected at TWR by OOI representatives prior to its first in-water tests to verify specifications for which inspection of the glider and accompanying documentation suffices. The glider will be initially inspected and bench tested with the 200m buoyancy engine. Modularity of the buoyancy engines will be demonstrated by swapping out to a 1000 m buoyancy engine and running through bench tests. After confirming the operation of the glider systems, the glider will be taken to a local body of water near TWR and WHOI for preliminary flotation/diving tests. After flotation/diving tests, the glider will be deployed in the vicinity of WHOI for approximately fourteen days under prevailing conditions. After recovery of the glider from this test, it will be crated and shipped to Oregon. After pre-deployment checkout, the test article will be deployed for a period of approximately fourteen days along the Newport hydrographic transect, also under prevailing conditions.

3 Planned Tests

There will be three phases of testing. The first phase consists of pre-deployment activities designed to confirm operation of the glider systems. The glider and documentation will first be inspected at TWR. Simulated missions will be run at TWR and/or WHOI to test communication by Freewave, Argos and Iridium, as well as confirm operation of glider controls. The final part of this phase is testing of the buoyancy engine and abort protocols in a body of water local to TWR and WHOI. Phase two is ocean deployment near Woods Hole, and will test operation of the glider in water from <60m to >200m deep. Phase three will test operation and behavior of the glider as it crosses the continental shelf near Oregon.

Phase one is similar to functional testing that will be performed routinely prior to production glider deployment. These tests address possible risks caused by, for instance, a blocked depth sensor or sticking buoyancy pump. Phase two tests glider deployment, operation, and recovery scenarios across the Atlantic continental shelf near the Pioneer Coastal Glider area. A map of the proposed route, including approximate round trip deployment and recovery times and glider flight times from selected points, is shown in Figure 2.

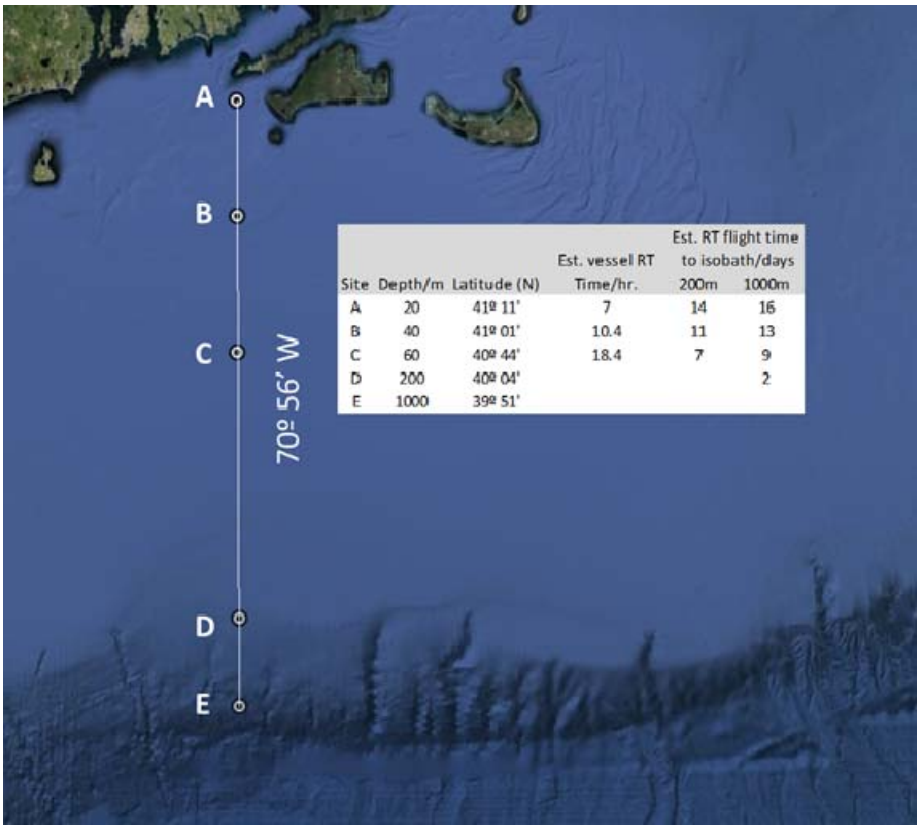

Figure 2: Pioneer Coastal Glider area test deployment route. Vessel round trip (RT) times are estimated to selected deployment/recovery sites from Great Harbor. Deployment depths at those sites are estimated from Google Earth. Glider flight times to/from those sites to 200m depth are estimated from an overall estimate of 25cm-sec-1 glider ground speed. Image from Google Earth.

Sampling strategies in this phase will be accelerated relative to those expected for production deployment in order to inform production sampling patterns and estimate true production deployment duration. One advantageous feature of gliders is their ability to adapt their mission to address short-term phenomena by receiving new mission commands while deployed. Sample adaptive missions, in the form of “virtual mooring” dives where the glider samples the water column

at a steady waypoint, are part of this phase. Phase three approximates a production deployment (glider deployment, operation, and recovery) mission across the Oregon shelf. The planned route and sea bottom profile are shown in Figure 3. The route extends from a near-shore site in approximately 20m water depth to 126º W longitude where the water depth is over 2000m. The exact deployment and recovery locations will be adjusted in response to the prevailing conditions at the time of the test, as a strong northward current is often encountered at depths shallower than ~100m.

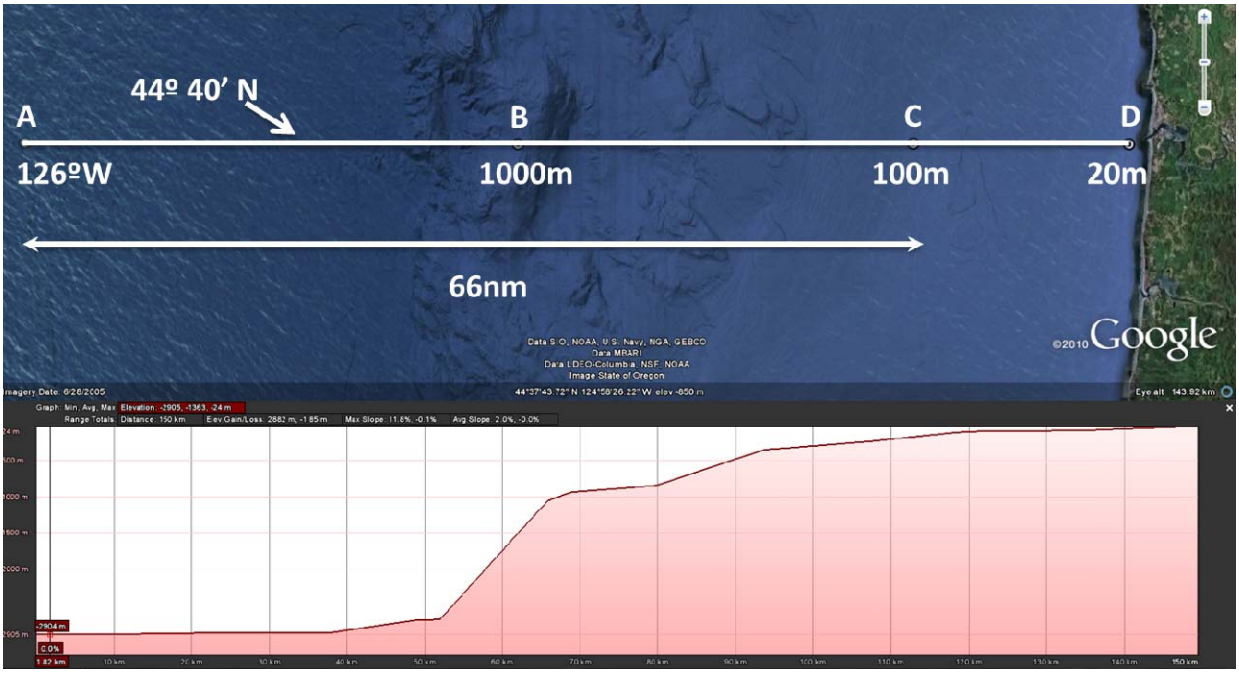

Figure 3: Endurance glider test route.
Starting point (C or D) is between 1 and 15 miles west of Newport, OR, and the end point is at 126º W (A). This path is an approximation to one of the proposed production glider routes. Image and bathymetry are from Google Earth.

During in-water testing (sheltered water, Atlantic Shelf, and Oregon Shelf), the glider will collect data from the scientific sensors. Data collected during the sheltered water testing will be examined by TWR and OOI test personnel to confirm that the instrumentation suite is ready for sea trials. Sea-trial scientific data will be examined by project scientists with relevant expertise. Data will be compared with historical data ranges in the deployment regions and known physical/chemical limits including static stability of density, oxygen saturation, and clear sky photosynthetically available radiation.

A notional time line for the testing is shown below:

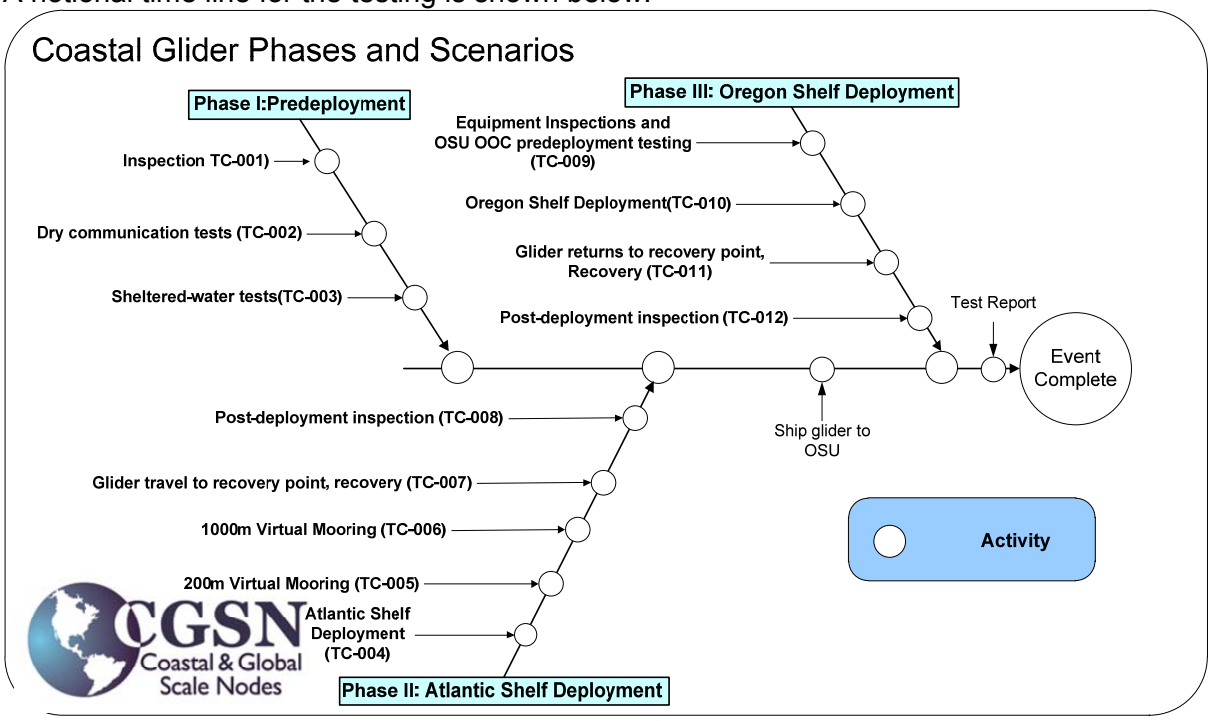

Figure 4: Notional timeline for coastal glider testing.

3.1 Predeployment Test Group

This test group describes testing activities that must be completed before the proceeding to in-water testing. This test group uses results from the FAT, performed by TWR and witnessed by OOI personnel, for demonstrations.

3.1.1 Inspections (TC-001), Ver-CG-45

The glider will be inspected by CGSN personnel to confirm presence of communications equipment, glider controls, sensors, glider markings, transportation case, and necessary tools and supplies for functional glider tests. All purchase and quality documents will be present and reviewed. Inspections will include inspections of instrument documentation to confirm all instrument meet mobile platform specifications.

3.1.1.1 Requirements Addressed

The set of coastal glider requirements addressed by this test case are summarized below:

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPEN-001	L4-CG-GD-RQ-167	Inspection Analysis	Analysis of glider ballasting range	Coastal gliders shall be capable of operating in a water temperature range of -2 degrees C to 30 degrees C.
OPEN-002	L4-CG-GD-RQ-168	Inspection Analysis	Analysis of glider ballasting range	Coastal gliders shall be capable of operating in a water salinity range of 0 to 40 psu (practical salinity units).
OPEN-004	L4-CG-GD-RQ-213	Inspection	Inspection of pump heads optimized for the two pressure ranges and the installation within the vehicle.	Coastal gliders shall be capable of being equipped with either one of a) a buoyancy engine optimized for 20-200 m dive depths or b) a buoyancy engine optimized for 1000 m dive depths.
POWR-005	L4-CG-GD-RQ-80	Inspection Analysis	No external power sources during deployment identified	Coastal gliders shall be self-powered for the duration of the deployment interval.
POWR-006	L4-CG-GD-RQ-169	Inspection Analysis	Review of wiring diagram regarding external power supply and connection.	Coastal gliders shall be capable of being powered by an external power source between deployments.
NAVG-002	L4-CG-GD-RQ-104	Inspection	Inspection of GPS receiver.	Coastal gliders shall be equipped with a GPS satellite navigation receiver.
NAVG-005	L4-CG-GD-RQ-107	Inspection	Review of GPS receiver documentation.	The geographic position shall be determined to an accuracy better than 20 meters.
NAVG-007	L4-CG-GD-RQ-109	Inspection	Review of GPS receiver documentation.	The GPS system time shall be determined to accuracy better than 1 seconds.
COMS-001	L4-CG-GD-RQ-72	Inspection	Inspection of LOS radio.	Coastal gliders shall carry a line of sight radio link.
COMS-002	L4-CG-GD-RQ-73	Inspection	Inspection of satellite recovery beacon.	Coastal gliders shall include a satellite based recovery beacon.
COMS-019	L4-CG-GD-RQ-120	Inspection (Documentation)	Inspection of communication file transfer code	Coastal glider communications protocol shall employ an error detection/correction protocol.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
COMS-023	L4-CG-GD-RQ-140	Inspection Demonstration	Inspection of Iridium receiver	Each coastal glider shall be equipped with a bi-directional satellite link that has the capability of transferring data to shore at a rate not less than 1200 bps
COMS-024	L4-CG-GD-RQ-141	Analysis	Global performance of Iridium will be assessed	Gliders shall be equipped with a bi-directional satellite communications link which is available more than 90% of the time anywhere on the surface of the earth.
SENS-003	L4-CG-GD-RQ-131	Inspection Demonstration	Inspection of altimeter manufacturer documentation and installation in glider.	Coastal gliders shall contain an altimeter capable of measuring altitude above bottom when within 30 meters of the bottom.
DATA-001	L4-CG-GD-RQ-77	Demonstration	Glider demonstration flight, and review of flight records	The controller shall have software and hardware to control and monitor the buoyancy generation, navigation, flight control, data acquisition, data storage, and telemetry subsystems.
DATA-002	L4-CG-GD-RQ-103	Inspection	Inspection of memory card capacity.	The total capacity of the nonvolatile memory shall be at least 1 Gb.
DATA-005	L4-CG-GD-RQ-110	Inspection Demonstration	Review clock data sheets.	The clock in the coastal glider controller shall be periodically synchronized to the GPS system time to maintain an accuracy of +/- 1 second relative to UTC.
OPSM-001	L4-CG-GD-RQ-84	Inspection	Inspect sensor installation	Science sensors shall be user-replaceable in the field with identical spare sensors.
OPSM-002	L4-CG-GD-RQ-85	Inspection	Inspect sensor installation and replacement instructions	Science sensor replacement (with identical spares) shall require no modification to the glider hardware or software. On board storage of instrument serial numbers and calibration coefficients is not construed as modification to glider software.
OPSM-004	L4-CG-GD-RQ-89	Inspection	Inspect the mission planning suite.	A mission planning program, spread sheet, model, or algorithm shall be provided to estimate glider energy requirements and communications bandwidth usage for operational scenarios and sensor payloads.
OPSM-005	L4-CG-GD-RQ-180	Inspection	Inspect LRU components and maintenance manual.	Vulnerable coastal glider components shall be field replaceable
OPSM-006	L4-CG-GD-RQ-181	Inspection	Inspect wing rail weight adjustment system.	Adjustable coastal glider ballasting shall be performed outside of the glider pressure case.
OPSM-007	L4-CG-GD-RQ-185	Inspection	Inspect the wiring diagram for external power switch.	Off state enabled by red shorting plug, verify presence
OPSM-009	L4-CG-GD-RQ-187	Inspection	Inspection of abort code and ejection weight	Coastal gliders shall have a fail-safe mechanism in which it becomes positively buoyant during an abort mode.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPSM-010	L4-CG-GD-RQ-188	Inspection	Review abort code documentation for overdepth behavior	Coastal gliders shall enter the abort mode when it exceeds its design depth by 10%
OPSM-011	L4-CG-GD-RQ-189	Inspection	Review abort code for leak behavior	Coastal gliders shall enter the abort mode when a leak is detected.
QUAL-003	L4-CG-GD-RQ-74	Inspection (Documentation)	Inspection and review of material selection, finish, and design.	The materials used in construction of the coastal glider, 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.
SHIP-004	L4-CG-GD-RQ-194	Analysis	Use Navy temperature test data to extrapolate to 6 month period.	Coastal gliders should be capable of being stored between 0 degrees F and 120 degrees F for periods of up to 6 months.
SHIP-005	L4-CG-GD-RQ-217	Inspection	Compare outer case dimensions against inner ISO container dimensions.	The coastal glider Transportation Case shall fit within an ISO shipping container.
SHIP-006	L4-CG-GD-RQ-195	Analysis	Use Navy shock and vibration test data, along with actual shipments to test locations.	Gliders shall be provided with reusable transportation cases that meet or exceed ASTM-D3951, "Standard Practice for Commercial Packaging."

Inspection and analysis will also be used to address verification of instruments selected for coastal gliders. Teledyne Webb will provide documentation received from instrument manufacturers. OOI engineers and scientists will perform inspection and any needed analyses. For CTD's, mobile platform specifications (1331-00001) are:

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
COND-007	L4-CG-IP-RQ-593	Analysis Test	Review of instrument specification and calibration provided by instrument manufacturer, analysis of historical performance of instrument	CTD conductivity measurements shall have an accuracy, for the full deployment interval, of ±0.0003 S•m-1 for CTD instruments on gliders and AUVs.
COND-004	L4-CG-IP-RQ-344	Analysis	As above	CTD conductivity measurements shall have an annual drift of no more than 0.004 S•m-1.
COND-005	L4-CG-IP-RQ-171	Analysis Test	As above	CTD conductivity measurements shall have a range of at least 0 to 7 S•m-1.
COND-006	L4-CG-IP-RQ-167	Analysis Test	As above	CTD conductivity measurements shall have a resolution of 0.00001 S•m-1.
TEMP-001	L4-CG-IP-RQ-342	Analysis Test	As above	CTD Temperature measurements shall have an accuracy of ±0.002 °C.
TEMP-002	L4-CG-IP-RQ-343	Analysis	As above	CTD Temperature measurements shall have an annual drift of no more than 0.01º C per year.
TEMP-003	L4-CG-IP-RQ-163	Analysis Test	As above	CTD Temperature measurements shall have a range of -2 to 35 °C.
TEMP-004	L4-CG-IP-RQ-159	Analysis Test	As above	CTD Temperature measurements shall have a resolution of 0.0001 °C.
PRES-001	L4-CG-IP-RQ-180	Analysis Test	As above	CTD Pressure sensors shall have a depth range consistent with the operational depth range of the host platform. CTD Pressure sensors on gliders and AUVs shall have a depth range of at least 1000 m.
PRES-003	L4-CG-IP-RQ-176	Analysis Test	As above	CTD Pressure sensors shall have an accuracy of ±0.1% for all of the full operational range.
PRES-004	L4-CG-IP-RQ-346	Analysis	As above	CTD Pressure sensors shall have an annual drift of no more than 0.05% for all of the full operational range.
PRES-005	L4-CG-IP-RQ-177	Analysis Test	As above	CTD Pressure sensors shall have a resolution of at least 0.002% for all of the full operational range.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
COND-008, TEMP-005, PRES-006	L4-CG-IP-RQ-162	Analysis Demonstration	As above	CTD instruments shall be capable of sampling at a sampling rate of 1 Hz.

For dissolved oxygen, mobile platform specifications (1331-00002) are:

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
DO2-003	L4-CG-IP-RQ-182	Analysis Test	Review of instrument specification and calibration provided by instrument manufacturer, analysis of historical performance of instrument	The DO instrument shall measure dissolved O_2 concentrations with an accuracy of ± 2% (with the value defined as that provided by a Winkler titration of a corresponding water sample).
DO2-001, DO2-002	L4-CG-IP-RQ-187	Analysis Demonstration Test	As above	The DO instrument shall measure dissolved O_2 concentrations within the range of 0-500 µmol/kg.
DO2-004	L4-CG-IP-RQ-183	Analysis Test	As above	The DO instrument shall measure dissolved O_2 concentrations with a resolution of at least 1.0 µmol/kg.
DO2-005	L4-CG-IP-RQ-348	Analysis	As above	The DO instrument shall measure dissolved O_2 concentrations with an annual drift of less than 10 µmol/kg.
SAMP-001	L4-CG-IP-RQ-559	Analysis Test	As above	DO instruments on mobile assets and profilers shall have a response time of 10 seconds or less for the measured DO to be ±95% of the change in value.
	L4-CG-IP-RQ-186	Analysis Demonstration Test	As above	DO instruments shall be capable of sampling at a rate of 1 sample every 2 seconds or faster.
	L4-CG-IP-RQ-560	Analysis Demonstration Test	As above	DO instruments should be capable of sampling at a rate of 1 sample every second or faster. This is an objective.

For multiple wavelength fluorometer/backscatter instruments, specifications (1331-00003) are:

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
BACK-001, BACK-002	L4-CG-IP-RQ-393	Analysis Demonstration Test	Review of instrument specification and calibration provided by instrument manufacturer, analysis of historical performance of instrument	Optical backscatter shall be measured over a dynamic range of no less than 0.001 bb(λ)/m to 0.2 bb(λ)/m.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
BACK-003	L4-CG-IP-RQ-223	Analysis Demonstration	As above	Optical backscatter instruments shall be capable of sampling intervals of no less than one time per second.
BACK-004	L4-CG-IP-RQ-551	Analysis Demonstration	As above	Optical backscatter instruments shall excite and measure in at least one band in the visible spectrum.
BACK-005	L4-CG-IP-RQ-552	Analysis Demonstration	As above	Optical backscatter instruments should excite and measure in two or more bands in the visible spectrum. This is an objective.
BACK-006	L4-CG-IP-RQ-659	Analysis Demonstration	As above	Optical backscatter instruments shall report measurements in all bands.
CHLO-001	L4-CG-IP-RQ-216	Inspection Analysis	As above	Chlorophyll-a fluorescence shall be measured with a linearity of 99% R2.
CHLO-001 CHLO-003	L4-CG-IP-RQ-217	Analysis Demonstration Test	As above	Chlorophyll-a fluorescence shall be measured over a range of 0.03 to 50 µg/L.
CHLO-004	L4-CG-IP-RQ-554	Analysis Demonstration	As above	Chlorophyll-a fluorescence should be measured over a range of 0.03 to 125 µg/L.
CHLO-007	L4-CG-IP-RQ-213	Analysis Demonstration	As above	Chlorophyll-a Fluorescence instruments shall measure emitted fluorescence between 675 and 700 nm induced by light excited between 425 and 490 nm.
	L4-CG-IP-RQ-218	Analysis Test	As above	Colored dissolved organic matter (CDOM) fluorescence shall be measured with a linearity of 99% R^2.
CHLO-006	L4-CG-IP-RQ-395	Analysis Demonstration	As above	Chlorophyll-a fluorescence instruments shall be capable of sampling intervals of no less than one time per second.
CDOM N-001 CDOM-002	L4-CG-IP-RQ-219	Analysis Demonstration Test	As above	CDOM fluorescence shall be measured over a range of 0.09 - 500 ppb.
CDOM-004	L4-CG-IP-RQ-214	Analysis Demonstration	As above	CDOM Fluorescence instruments shall measure emitted fluorescence between 425 and 480 nm induced by light excited between 345 and 380 nm.
CDOM-003	L4-CG-IP-RQ-397	Analysis Demonstration	As Above	CDOM fluorescence instruments shall be capable of sampling intervals of no less than one time per second.

For photosynthetically available radiation, relevant specifications (1331-00005) are:

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
PAR-001	L4-CG-IP-RQ-390	Analysis Demonstration Test	Review of instrument specification and calibration provided by instrument manufacturer, analysis of historical performance of instrument	The instrument shall measure PAR over a range with a minimum value of 0.1 µmol photons m^{-2} s^{-1}.
PAR-002	L4-CG-IP-RQ-390	Analysis Demonstration Test	As above	The instrument shall measure PAR over a range of with a maximum value of 2000 µmol photons m^{-2} s^{-1}.
PAR-003	L4-CG-IP-RQ-388	Analysis Test	As above	PAR shall be measured with an accuracy of ±5% for the full range of the instrument.
PAR-004	L4-CG-IP-RQ-389	Analysis Test	As above	PAR instruments shall have a resolution of 0.01 µmol photons m^{-2} s^{-1}.
PAR-005	L4-CG-IP-RQ-391	Analysis Demonstration	As above	The PAR instrument shall be capable of sampling at a frequency of 1 Hz.
PAR-006	L4-CG-IP-RQ-387	Analysis Demonstration	As above	PAR shall be measured within a wavelength range from 400 nm to 700 nm.

For velocity profile measurements, relevant specifications (3305-00009) are:

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
VELP-001	L4-CG-IP-RQ-466	Analysis Test	Review of instrument specification and calibration provided by instrument manufacturer, analysis of historical performance of instrument	Velocity profile instruments shall have a speed range with a minimum value of 0 m/s.
VELP-002	L4-CG-IP-RQ-467	Analysis Test	As above	Velocity profile instruments shall have a direction range with a minimum value of 0 degrees
VELP-003	L4-CG-IP-RQ-466	Analysis Test	As above	Velocity profile instruments shall have a speed range with a maximum value of 4 m/s.
VELP-004	L4-CG-IP-RQ-467	Analysis Test	As above	Velocity profile instruments shall have a direction range with a maximum value of 360 degrees
VELP-005	L4-CG-IP-RQ-468	Analysis Test	As above	Velocity profile instruments shall have a speed accuracy of 1% of measured value +/- 1 cm/s.
VELP-006	L4-CG-IP-RQ-469	Analysis Test	As above	Velocity profile measurements shall have an absolute direction accuracy of +/- 2 degrees

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
VELP-007	L4-CG-IP-RQ-470	Analysis Test	As above	Velocity profile instruments shall have a single sample speed precision of no greater than 3 cm/s.
VELP-008	L4-CG-IP-RQ-471	Analysis Test	As above	Velocity profile instruments shall have a speed resolution of 0.1 cm/s.
VELP-009	L4-CG-IP-RQ-472	Analysis Test	As above	Velocity profile instruments shall have a direction resolution of 0.1 degrees
VELP-010	L4-CG-IP-RQ-473	Analysis Demonstration	As above	Velocity profile instruments shall be capable of sampling at a frequency of 1 Hz
VELP-011	L4-CGIP-RQ-474	Analysis Demonstration	As above	Velocity profile instruments shall be capable of burst sampling
VELP-012	L4-CG-IP-RQ-475	Analysis Demonstration	As above	Velocity profile instruments shall have a variable number of depth bins numbering no less than 100.
VELP-013	L4-CG-IP-RQ-476	Analysis Demonstration	As above	Velocity profile instruments shall have a variable depth bin size with a minimum size of 0.5 m.
VELP-014	L4-CG-IP-RQ-477	Analysis Test	As above	Velocity profile instruments shall be capable of measuring water velocity over a range of 20 m, upward and downward.
VELP-015	L4-CG-IP-RQ-478	Analysis Test	As above	Velocity profile instruments shall be capable of measuring water velocity over a range of 100 m. This is an objective.
VELP-016	L4-CG-IP-RQ-479	Analysis Demonstration	As above	Velocity profile instruments shall be capable of providing bottom-track velocity.
VELP-017	L4-CG-IP-RQ-480	Analysis Demonstration	As above	Velocity profile instruments shall be capable of providing bottom-track distance to seafloor.
VELP-018	L4-CG-IP-RQ-483	Analysis Demonstration	As above	Velocity profile instruments shall provide a quantitative measure of acoustic backscatter intensity for each bin.
OPER-001	L4-CG-IP-RQ-446; L3-CG-RQ-867	Inspection Analysis	As above	Sensors shall utilize biofouling mitigation to enable nominal operations over the defined deployment interval.
OPER-002	L4-CG-IP-286	Analysis	As above	Sensors should maintain their calibration over the required deployment intervals. This is an objective.
DATA-001	L4-CG-IP-RQ-481	Analysis Demonstration	As above	Velocity profile instruments shall be capable of computing three components of velocity in geographic coordinates (east, north, up) internal to the instrument.
DATA-002	L4-CG-IP-RQ-482	Analysis Demonstration	As above	Velocity profile instruments shall be capable of averaging velocity in geographic coordinates (east, north, up) internal to the instrument.

3.1.1.2 Pre-conditions

Completion and documentation of all glider FAT's, third-party calibrations and documents, glider assembled with 1000 m buoyancy engine to be provided by Teledyne Webb, Iridium SIM card to be provided by CGSN, Argos ID to be provided by CGSN

3.1.1.3 Hardware Preparation

None

3.1.1.4 Software Preparation

None

3.1.1.5 Test Inputs

None

3.1.1.6 Expected Results

All systems will be present. Documentation of manufacture will show compliance with relevant OOI requirements and specifications.

3.1.1.7 Criteria for Evaluating Results

Observing presence of equipment or relevant documentation will be considered passage for each item.

3.1.2 Communications and dry tests (TC-002)- Ver-CG-56

This case will test the power and communications devices on the glider. Mechanical controls and sensors will also be exercised. Dry testing will be performed first with the 200m buoyancy pump. The buoyancy system will then be swapped to the 1000m system and the tests repeated.

3.1.2.1 Requirements Addressed

The set of requirements addressed by this test case is below.

Spec. ID	Requirement ID	Verification Method	Verification Approach	Specification Text
POWR-006	L4-CG-GD-RQ-169	Inspection Analysis	Power up on bench	Coastal gliders shall be capable of being powered by an external power source between deployments.
NAVG-004	L4-CG-GD-RQ-106	Demonstration	Move glider from GPS-blocked location, measure time to acquire signal	Coastal gliders shall be equipped with a GPS receiver capable of obtaining a fix within a maximum of 5 min after surfacing.
COMS-007	L4-CG-GD-RQ-172	Demonstration	Glider demonstration flight or simulation.	Coastal glider trajectories shall be programmable by commands sent via the short range high speed radio link.
COMS-010	L4-CG-GD-RQ-173	Demonstration	Glider demonstration flight or simulation.	Sampling protocols shall be programmable via the high speed short range radio link.
COMS-022	L4-CG-GD-RQ-123	Demonstration	Glider simulation with set file transfer.	Coastal glider communications link shall transfer data at an average rate exceeding 30 bytes per second including the time spent establishing and tearing down the link.
COMS-023	L4-CG-GD-RQ-140	Inspection Demonstration	Send a known-size file from the glider through Iridium, measure transfer time.	Each coastal glider shall be equipped with a bi-directional satellite link that has the capability of transferring data to shore at a rate not less than 1200 bps
OPSM-013	L4-CG-GD-RQ-192	Demonstration	Glider demonstration flight, review of flight records.	Coastal gliders shall monitor and record internal pressure.
OPSM-014	L4-CG-GD-RQ-193	Demonstration	Wet the leak detect sensors and verify glider output.	Coastal gliders shall monitor and record internal leaks.

3.1.2.2 Pre-conditions

A computer running Dockserver must be available and able to communicate with the glider via Freewave and Iridium. A power supply and fittings for bench-powering the glider are required. A pump capable of generating 7 inHg vacuum is required.

3.1.2.3 Hardware Preparation

The glider will be prepared following the Closing Procedure section of the Slocum Operator's Manual and mounted either on its wheeled dolly or other movable fixture capable of going between the high bay and adjacent parking lot.

3.1.2.4 Software Preparation

The glider controller will be in the Lab mode.

3.1.2.5 Test Inputs

Suitable simulated mission files

3.1.2.6 Expected Results

The glider will respond appropriately to commands.

3.1.2.7 Criteria for Evaluating Results

Communication systems will function properly. The glider will not give unexpected error messages.

3.1.3 Pre-deployment Sheltered-water Testing (TC-003)- Ver-CG-55

This case describes predeployment wet test activities to be conducted at body of water local to WHOI and TWR. These activities are designed to complement the dry tests performed in TC-001 and TC-002 to give confidence that the test article is ready for sea trials with minimal risk of loss due to system failure.

3.1.3.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPEN -005	L4-CG-GD-RQ-130	Demonstration	Glider demonstration flight within a total 20m water depth, review of flight records.	Coastal Gliders shall operate in a minimum total water depth of 20m.
OPEN -008	L4-CG-GD-RQ-216	Demonstration	Demonstrated deployment and recoveries based on small boat.	Coastal gliders shall be designed so that deployment and recovery can be performed without powered lifting equipment or mounted ship fittings.
NAVG -003	L4-CG-GD-RQ-105	Demonstration	Glider demonstration flight, review of flight records.	Coastal gliders shall obtain GPS position when surfaced.
NAVG -006	L4-CG-GD-RQ-108	Demonstration	Surface glider from submerged, compare glider GPS time	Coastal gliders shall obtain GPS time when surfaced.
COMS -004	L4-CG-GD-RQ-79	Demonstration	Glider demonstration flight, review of flight records.	The controller shall have the capability to turn off sensors or instruments that malfunction or when directed by commands from the shore station.
COMS -014	L4-CG-GD-RQ-112	Demonstration	Glider demonstration flight or simulation.	Coastal gliders shall establish a telemetry link when surfaced.
COMS -018	L4-CG-GD-RQ-117	Demonstration	Glider demonstration flight or simulation.	The specification of the averaging, decimation or other processing of the data shall be programmable via the satellite communications link.
SENS-004	L4-CG-GD-RQ-174 L3-CG-RQ-315 L3-CG-RQ-404	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall carry, power and operate sensors for measurement of conductivity, temperature, and pressure (CTD).
SENS-005	L4-CG-GD-RQ-175 L3-CG-RQ-316 L3-CG-RQ-405	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall carry, power and operate sensors for measurement of dissolved oxygen.
SENS-006	L4-CG-GD-RQ-215 L3-CG-RQ-735 L3-CG-RQ-892	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall carry, power and operate sensors for measurement of photosynthetically available radiation (PAR).

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
SENS-007	L4-CG-GD-RQ-177 L3-CG-RQ-317 L3-CG-RQ-403	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall carry, power and operate sensors for measurement of optical backscatter, chlorophyll a fluorescence, and colored dissolved organic matter (CDOM) fluorescence.
SENS-008	L4-CG-GD-RQ-178 L3-CG-RQ-318 L3-CG-RQ-406	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall carry, power and operate sensors for measurement of relative mean water horizontal velocity profiles
DATA-003	L4-CG-GD-RQ-102	Demonstration	Glider demonstration flight, and review of flight records.	All scientific, navigation, and engineering diagnostic data collected by the coastal gliders shall be time-stamped and recorded internally in a nonvolatile memory.
DATA-005	L4-CG-GD-RQ-110	Inspection Demonstration	Demonstrate clock synchronization	The clock in the coastal glider controller shall be periodically synchronized to the GPS system time to maintain an accuracy of +/- 1 second relative to UTC.
DATA-006	L4-CG-GD-RQ-111	Demonstration	Glider demonstration flight, and review of flight records.	Coastal glider system time shall be incorporated with recorded scientific data.
DATA-007	L4-CG-GD-RQ-179	Demonstration	Glider demonstration flight, and review of flight records.	Coastal glider GPS position shall be incorporated with recorded scientific data.
OPSM-008	L4-CG-GD-RQ-186	Inspection	Demonstrate abort scenarios	Coastal gliders shall have an abort mode in which the mission is ended and the glider returns the surface and signals.
OPSM-012	L4-CG-GD-RQ-191	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall record and report buoyancy engine state (e.g. piston throw, bladder level) during its deployment

3.1.3.2 Pre-conditions

A computer running Dockserver must be available and able to communicate with the glider via Freewave and Iridium. A boat suitable for deploying the glider in a body of water near WHOI and TWR will be available. To the extent possible, sensors similar to those carried by the glider will be available to validate the glider sensor readings.

3.1.3.3 Hardware Preparation

The glider will be prepared for sea per TWR's Slocum Operators Guide. Ballasting will not be required, as the glider should be factory-ballasted.

3.1.3.4 Software Preparation

Dockserver must be running. The glider must be running GliderDOS.

3.1.3.5 Test Inputs

The glider will be given mission commands designed to test various engineering and sensor functions.

3.1.3.6 Expected Results

Glider controls will react in predictable ways to commands. Abort scenarios will give the expected abort codes. Sensors will operate as expected, and will give reasonable results.

3.1.3.7 Criteria for Evaluating Results

Glider control responses are consistent with commands. The glider will not report errors or oddities that might cause a mission-ending abort or loss of sensor functionality.

3.2 Deployment Test Group, Atlantic Shelf

This group describes deployment tests in or near the Pioneer array location.

3.2.1 Cross-shelf transit outbound (TC-004)- Ver-CG-54

The glider will be deployed as close as practical to the Pioneer array area. It will demonstrate the ability to navigate and acquire data in water from the deployment depth (minimum 20m) to greater than 1000m water depth during programmed flight.

3.2.1.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPEN-003	L4-CG-GD-RQ-129 L3-CG- RQ-733 L3-CG- RQ-863	Demonstration	Glider demonstration flight to 1000m depth.	Coastal glider hulls, navigation systems, communication systems, and core sensors shall operate and maintain full functionality from the surface to a dive depth of at least 1000m.
OPEN-006	L4-CG-GD-RQ-132	Demonstration	Glider demonstration flight, and review of flight records.	Coastal gliders shall be capable of flying to within 3 meters of the bottom without impacting the bottom.
OPEN-007	L4-CG-GD-RQ-133	Demonstration	Glider demonstration flight, and review of flight records.	In the absence of wave effects, coastal gliders shall be capable of sampling within 3m of the seafloor without coming into contact with the bottom.
OPEN-008	L4-CG-GD-RQ-216	Demonstration	Demonstrated deployment based on Tioga (or other available vessel)..	Coastal gliders shall be designed so that deployment and recovery can be performed without powered lifting equipment or mounted ship fittings.
NAVG-001	L4-CG-GD-RQ-97	Demonstration	Glider demonstration flight, review of flight records.	Coastal gliders shall be capable of navigating between a predetermined list of waypoints using updated position data obtained from the GPS constellation.
NAVG-008	L4-CG-GD-RQ-170	Inspection	Review of mission code and dive parameters.	Coastal glider descent depth shall be programmable to within the larger of +-0.5% of dive depth or +-1 m.
NAVG-009	L4-CG-GD-RQ-171	Demonstration	Glider demonstration flight, review of flight records.	The coastal glider shall be capable of a horizontal velocity of 35 cm/s relative to water when averaged over the vertical extent of each complete dive cycle.
COMS-003	L4-CG-GD-RQ-78	Demonstration	Glider demonstration flight, review of flight records.	As power becomes limited, the controller shall have the capability to reduce overall system functionality according to priorities programmed by the user or as directed by commands from the shore station.
COMS-005	L4-CG-GD-RQ-90	Demonstration	Glider demonstration flight and input to the mission planning module.	The mission planning program shall be configurable to estimate a coastal glider's remaining operational life based on near real time data from the field.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
COMS-006	L4-CG-GD-RQ-95 L3-CG- RQ-313 L3-CG- RQ-401	Demonstration	Glider demonstration flight.	Coastal glider trajectories shall be programmable by commands sent via the satellite link.
COMS-009	L4-CG-GD-RQ-98 L3-CG- RQ-738	Demonstration	Glider demonstration flight.	Sampling protocols shall be programmable through the satellite communications link.
COMS-011	L4-CG-GD-RQ-99	Demonstration	Glider demonstration flight, review of flight records.	The order in which the waypoints are visited shall be programmable through the satellite communications link.
COMS-012	L4-CG-GD-RQ-100	Demonstration	Glider demonstration flight, review of flight records.	The tolerances to which coastal gliders attempt to satisfy the route shall be programmable through the satellite communications link.
COMS-013	L4-CG-GD-RQ-101	Demonstration	Glider demonstration flight, review of flight records.	The route, waypoints, and navigational tolerance parameters currently in use shall be reported to the shore station upon receipt of a command through the satellite communications link.
COMS-015	L4-CG-GD-RQ-113	Demonstration	Glider demonstration flight, review of flight records.	Coastal gliders shall surface and communicate with the shore station at least once daily using the satellite communications link.
COMS-016	L4-CG-GD-RQ-114 L3-CG- RQ-314 L3-CG- RQ-402	Demonstration	Glider demonstration flight or simulation.	Coastal gliders shall be capable of transmitting compressed data or subsets of data via the satellite telemetry link when on the surface
COMS-017	L4-CG-GD-RQ-116	Demonstration	Glider demonstration flight, review of flight records.	Coastal glider data offload schedules shall be programmable from shore by sending commands via the satellite link.
COMS-020	L4-CG-GD-RQ-121	Demonstration	Glider demonstration flight with communication through Iridium RUDICS link and Dockserver.	Coastal glider communications link shall be capable of transferring 100 kilobytes per day from each glider to the shore station.
COMS-025	L4-CG-GD-RQ-156	Demonstration	Glider demonstration flight or simulation with data transfer and sampling rate modifications.	The parameters and criteria governing the data transfer rate shall be programmable by the ground station through the satellite communications link.
SENS-002	L4-CG-GD-RQ-119	Demonstration	Glider demonstration flight, review of flight records.	Sensors shall be sampled such that the vertical resolution of their measurement parameter is not more than 1 m.

3.2.1.2 Pre-conditions

The glider will have passed all predeployment tests, and be prepared for ocean deployment per the Slocum Operators Manual. Deploying at 40m depth near the coast will require approximately 8 hours of ship time and 10 hours for each person involved in the deployment. During the deployment interval, a designated OOI member must keep a phone or pager within reach for glider emergency communication, and be able to respond immediately if an emergency recovery is required. Emergency recovery at the extreme end of the glider flight path could entail up to a 2-day roundtrip cruise for a vessel like the Tioga.

3.2.1.3 Hardware Preparation

See above

3.2.1.4 Software Preparation

The glider will be running GliderDOS at deployment.

3.2.1.5 Test Inputs

A mission plan for the round-trip from deployment site to the desired return point will be loaded into the glider. Where the depth is less than 1000m, the glider mission depth will be set to within 3m of the seafloor as measured by the altimeter, and will collect data within 3m of the seafloor. Sensor usage will be set so that COMS-020 and COMS-022 can be demonstrated.

3.2.1.6 Expected Results

The glider will follow the mission instructions, and will correctly insert subsequent commands from the Dockserver. The mission planning software will show updated estimates of remaining operational life based on telemetered battery-usage data.

3.2.1.7 Criteria for Evaluating Results

Deployment will be accomplished without special/powered lifting equipment (note: ”special” does not include equipment supplied with the glider). Waypoints will be reached within programmed tolerances. Engineering and sensor data will be recorded in correct format per mission programming. Data transfer rate and daily volume will be set to meet or exceed specified minimums. Where available, corroborative sources will be used to validate scientific data collected by the glider.

3.2.2 Virtual Mooring to approximately 200m depth (TC-005)- Ver-CG-53

The glider can act as a virtual mooring. It will navigate to a predetermined position ("station") during its cross-shelf flight. It will descend on-station to within 3 meters of the bottom while acquiring data, and then return to the surface on-station. At the completion of this dive, the glider will continue as programmed.

3.2.2.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
COMS-008	L4-CG-GD-RQ-96	Demonstration	Glider demonstration flight.	Coastal gliders shall retrieve any updated mission files which might be queued at the shore station.

3.2.2.2 Pre-conditions

The glider will have successfully passed TC-001 through TC-003 in this test plan, and be executing the TC-004 outbound transit when the virtual mooring dive commands are issued. The glider will have arrived at the selected dive location (200m isobath).

3.2.2.3 Hardware Preparation

No hardware modifications

3.2.2.4 Software Preparation

No modifications except for mission plan

3.2.2.5 Test Inputs

Mission inputs for the virtual-mooring dive and sensor information must be communicated to the glider. Commands will be queued from the Dockserver while the glider is in transit. The dive termination, set by glider altitude, will be within 3 meters of the seafloor.

3.2.2.6 Expected Results

The glider will retrieve the mission file and complete the mooring dive and surface return. Estimated time from start of dive to surface return is approximately 1-2 hours depending on maximum depth. Maximum depth will be within 3 meters of the bottom, according to altimeter and CTD data. The glider will return to its trans-shelf course after completion of this dive.

3.2.2.7 Criteria for Evaluating Results

Observed behavior will be evaluated for: successful retrieval of mission file, distance from dive location to return location; minimum approach to seabed. Where available, corroborative sources will be used to validate scientific data collected by the glider.

3.2.3 Virtual Mooring to 1000m depth (TC-006)- Ver-CG-52

The glider can act as a virtual mooring. It will navigate to a predetermined position ("station") during its cross-shelf flight. The station will be in water deeper than 1000m. The glider will descend on-station to 1000m depth while acquiring data, and then return to the surface on-station. At the completion of this dive, the glider will continue as programmed.

3.2.3.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
COMS-021	L4-CG-GD-RQ-122	Demonstration	Glider demonstration flight or simulation with extrapolation for the Iridium RUDICS link and Dockserver.	Coastal glider communications link shall be capable of transferring 5 kilobytes per day from the shore station to each glider.

3.2.3.2 Pre-conditions

The glider will have successfully passed TC-001 through TC-003 in this test plan, and be executing the TC-004 outbound transit when the virtual mooring dive commands are issued. The glider will have arrived at the selected dive location (1000m isobath).

3.2.3.3 Hardware Preparation

No hardware modifications.

3.2.3.4 Software Preparation

No modifications except for mission plan

3.2.3.5 Test Inputs

Mission inputs for the virtual-mooring dive and sensor information must be communicated to the glider. Commands will be queued from the Dockserver while the glider is in transit. Maximum depth will be set to 1000m depth. Sampling protocol will be altered to shut off bio-optical sensors and PAR below 200m.

3.2.3.6 Expected Results

The glider will retrieve the mission file from queue and complete the mooring dive and surface return. Estimated time from start of dive to surface return is approximately 6 hours. Maximum depth will be 1000 meters, according to pressure sensor and CTD data.

3.2.3.7 Criteria for Evaluating Results

Observed behavior will be evaluated for: successful retrieval of mission file from queue, distance from dive location to return location; maximum depth. Where available, corroborative sources will be used to validate scientific data collected by the glider.

3.2.4 Return to Atlantic Shelf recovery point, recovery (TC-007)- Ver-CG-51

The glider will follow a programmed course to a recovery point determined during the glider deployment. Recovery will use the nose system.

3.2.4.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Requirement ID	Verification Method	Verification Approach	Specification Text
OPEN-008	L4-CG-GD-RQ-216	Demonstration	Demonstrated recoveries based on Tioga (or other available vessel).	Coastal gliders shall be designed so that deployment and recovery can be performed without powered lifting equipment or mounted ship fittings.

3.2.4.2 Pre-conditions

The glider will have successfully passed all preceding steps in this test plan.

3.2.4.3 Hardware Preparation

No hardware modifications

3.2.4.4 Software Preparation

No modifications except for mission plan

3.2.4.5 Test Inputs

Mission inputs for the return course must be communicated to the glider. Commands will be queued from the Dockserver while the glider is in transit. Depending on sea state, the recovery nose will be either triggered as the primary recovery device or will be triggered in a mini-mission performed after a conventional recovery and redeployment.

3.2.4.6 Expected Results

The glider will complete the return trip to the recovery point. Recovery will not present unusual complications. The recovery nose will perform as expected.

3.2.4.7 Criteria for Evaluating Results

The return voyage will not result in unusual aborts or equipment failures. Recovery will be accomplished without special/powered lifting equipment (note: ”special” does not include equipment supplied with the glider). Where available, corroborative sources will be used to validate scientific data collected by the glider.

3.2.5 Post-recovery Evaluation, Atlantic (TC-008)- Ver-CG-50

The glider will be examined for signs of biofouling and other effects. Battery usage after deployment will be compared to prediction and analyzed for compliance with required endurance.

3.2.5.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
POWR-001	L4-CG-GD-RQ-126	Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available.	Coastal gliders shall have a deployment interval of three months.
POWR-002	L4-CG-GD-RQ-128	Analysis	Glider demonstration flight extrapolated horizontal range.	Over the deployment interval, coastal gliders shall have a minimum horizontal range through the water of 1800 kilometers.
POWR-003	L4-CG-GD-RQ-82	Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available.	Coastal gliders shall have sufficient power to operate the controller with full functionality for the required deployment interval.
POWR-004	L4-CG-GD-RQ-76	Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available with the glider in a low energy state.	The coastal glider shall have sufficient battery reserves to allow the coastal glider controller, GPS location system, and telemetry system to remain functional for 60 days following the end of the planned deployment interval.
POWR-005	L4-CG-GD-RQ-80	Inspection Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available.	Coastal gliders shall be self-powered for the duration of the deployment interval.
DATA-002	L4-CG-GD-RQ-91	Analysis	Glider demonstration flight, analysis of flight records and extrapolation for full deployment interval.	The data storage subsystem shall have data storage capacity to store all of the coastal glider engineering and sensor data collected during a deployment interval

3.2.5.2 Pre-conditions

The glider will have successfully passed all preceding steps in this test plan.

3.2.5.3 Hardware Preparation

No hardware modifications

3.2.5.4 Software Preparation

None

3.2.5.5 Test Inputs

None.

3.2.5.6 Expected Results

The glider will show minimal biofouling or other damage.

3.2.5.7 Criteria for Evaluating Results

Biofouling should not be severe enough to cause performance degradation. Analysis of battery usage and glider forward speed in linear flight should indicate that the glider meets the requirements L4-CG-GD-RQ-126, L4-CG-GD-RQ-128, and L4-CG-GD-RQ-82. Analysis of data storage consumption should indicate that the glider meets the requirement associated with DATA specification. Analysis of the reserve battery capacity will verify L4-CG-GD-RQ-76

3.3 Deployment Test Group, OSU/Oregon Shelf

This group describes deployment tests in or near the Endurance array location.

3.3.1 Predeployment testing, Oregon Shelf (TC-009)- Ver-CG-49

After shipment to OSU, glider functional tests will be performed to assure that the glider did not sustain function-impairing damage in transit from Massachusetts to Oregon State. A battery replacement will be simulated by removing the battery packs and reinstalling them.

3.3.1.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPSM-003	L4-CG-GD-RQ-87	Demonstration	Glider demonstration simulated refurbishment and re-deployment.	Coastal gliders shall be recoverable and reusable following refurbishment and refueling.

3.3.1.2 Pre-conditions

The glider will be delivered to the OOC. Before proceeding to powered testing, the glider will be inspected for obvious damage.

3.3.1.3 Hardware Preparation

The glider will be disassembled to inspect for internal damage and then reassembled per the Slocum Operator's Guide

3.3.1.4 Software Preparation

The glider will be in lab mode for land testing

3.3.1.5 Test Inputs

Simulated missions for exercising various glider functions

3.3.1.6 Expected Results

The glider will give predictable responses to test inputs.

3.3.1.7 Criteria for Evaluating Results

The glider simulated refurbishment will leave the glider ready to redeploy. All responses must be within expected ranges. No persistent errors will be noted in predeployment testing. The glider will be functionally considered ready for deployment along the Endurance Newport line.

3.3.2 Deployment testing, Oregon Shelf (TC-010)- Ver-CG-48

This test case is similar to at-sea tests for the Atlantic Shelf deployment. Conditions for this test are planned to mimic actual production deployment.

3.3.2.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPEN-008	L4-CG-GD-RQ-216	Demonstration	Demonstrated deployment based on Elakha (or other available vessel).	Coastal gliders shall be designed so that deployment and recovery can be performed without powered lifting equipment or mounted ship fittings.

3.3.2.2 Pre-conditions

The nose release system will have been reset (this may occur before shipment or after receipt at the OOC). The glider will be prepared for sea per the Slocum Operator's Guide. The glider may require reballasting if the expected water density in the deployment area is different than the density for which the glider was originally ballasted. Deploying at 20m depth near the coast will require approximately 3 hours of ship time and 8 hours for each person involved in the deployment. During the deployment interval, a designated OOI member must keep a phone or pager within reach for glider emergency communication, and be able to respond immediately if an emergency recovery is required. Emergency recovery at the extreme end of the glider flight path could entail up to a 2-day round-trip cruise for a vessel like the Elakha.

3.3.2.3 Hardware Preparation

FreeWave communication will be available

3.3.2.4 Software Preparation

Glider will be running GliderDOS. FreeWave communication will be available

3.3.2.5 Test Inputs

Mission plans to resolve any issues from the Atlantic Shelf deployment, and mission plans for conditions unique to the Endurance expected usage

3.3.2.6 Expected Results

The glider will follow mission commands (waypoints and science sensor protocols) it is given.

3.3.2.7 Criteria for Evaluating Results

Deployment will be accomplished without special/powered lifting equipment (note:"special" does not include equipment supplied with the glider). The glider must behave in a manner consistent with full-scale deployability. All sensors and controls will function properly. The glider will display controllable flight in 20m depth water.

3.3.3 Return to Oregon Shelf recovery point, recovery (TC-011)- Ver-CG-47

The glider will follow a programmed course to a recovery point determined during the glider deployment. Recovery will use the nose system.

3.3.3.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
OPEN-008	L4-CG-GD-RQ-216	Demonstration	Demonstrated recoveries based on Elakha (or other available vessel).	Coastal gliders shall be designed so that deployment and recovery can be performed without powered lifting equipment or mounted ship fittings.

3.3.3.2 Pre-conditions

The glider will have successfully passed all preceding steps in this test plan and will have arrived at the recovery point. Recovery at 20m depth near the coast will require approximately 3 hours of ship time and 8 hours for each person involved in the recovery.

3.3.3.3 Hardware Preparation

No hardware modifications

3.3.3.4 Software Preparation

No modifications except for mission plan

3.3.3.5 Test Inputs

Mission inputs for the return course must be communicated to the glider. Commands will be queued from the Dockserver while the glider is in transit. Depending on sea state, the recovery nose will be either triggered as the primary recovery device or will be triggered in a mini-mission performed after a conventional recovery and redeployment.

3.3.3.6 Expected Results

The glider will complete the return trip to the recovery point. Recovery will not present unusual complications. The recovery nose will perform as expected.

3.3.3.7 Criteria for Evaluating Results

Recovery will be accomplished without special/powered lifting equipment (note:”special” does not include equipment supplied with the glider). The return voyage will not result in unusual aborts or equipment failures. Where available, corroborative sources will be used to validate scientific data collected by the glider.

3.3.4 Post-recovery evaluation, Pacific (TC-012)- Ver-CG-46

The glider will be examined for signs of biofouling and other effects. Power consumption will be compared to telemetered data. Speed and remaining power will be used to verify range and endurance requirements.

3.3.4.1 Requirements Addressed

Requirements addressed by this test group are presented below.

Spec. ID	Require-ment ID	Verification Method	Verification Approach	Specification Text
POWR-001	L4-CG-GD-RQ-126	Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available.	Coastal gliders shall have a deployment interval of three months.
POWR-002	L4-CG-GD-RQ-128	Analysis	Glider demonstration flight extrapolated horizontal range.	Over the deployment interval, coastal gliders shall have a minimum horizontal range through the water of 1800 kilometers.
POWR-003	L4-CG-GD-RQ-82	Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available.	Coastal gliders shall have sufficient power to operate the controller with full functionality for the required deployment interval.
POWR-004	L4-CG-GD-RQ-76	Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available with the glider in a low energy state.	The coastal glider shall have sufficient battery reserves to allow the coastal glider controller, GPS location system, and telemetry system to remain functional for 60 days following the end of the planned deployment interval.
POWR-005	L4-CG-GD-RQ-80	Inspection Analysis	Glider demonstration flight and extrapolated analysis based on energy usage vs. energy available.	Coastal gliders shall be self-powered for the duration of the deployment interval.

3.3.4.2 Pre-conditions

The glider will have successfully passed all preceding steps in this test plan.

3.3.4.3 Hardware Preparation

No hardware modifications

3.3.4.4 Software Preparation

None

3.3.4.5 Test Inputs

None.

3.3.4.6 Expected Results

The glider will show minimal biofouling or other damage. Data and power usage will be consistent with capacity to complete a 3-month deployment interval.

3.3.4.7 Criteria for Evaluating Results

Biofouling should not be severe enough to cause performance degradation. Analysis of battery usage and glider forward speed in linear flight should indicate that the glider meets the requirements L4-CG-GD-RQ-126, L4-CG-GD-RQ-128, and L4-CG-GD-RQ-82. Analysis of the reserve battery capacity will verify L4-CG-GD-RQ-76. All systems will show minimal wear, and the glider will be ready for refueling and redeployment. Battery and data usage will agree with projections.

4 Data Collection and Analysis Plan

Engineering data collection parameters are set by the glider software. Engineering data will be stored complete on a 2GB flash memory card on the glider control Persistor and telemetered in decimated form to the Dockserver. Sensor data collection protocols will be varied during the course of the deployments to demonstrate adaptability of science protocols and determine glider behavior during various combinations of power and data loads. Science sensor data will be stored in complete form on the 2GB flash memory card on the science bay control Persistor and telemetered to shore in decimated form as short burst data files. Decimation protocols will be varied during the course of the deployment to demonstrate adaptability of the telemetry to shore commands.

Telemetered data will be inspected as it is received from the glider for signs of obvious file corruption or indication of sensor fault. Glider data will be added to the Thematic Realtime Environmental Distributed Data Services (THREDDS) data stream sent to the CyberInfrastructure IO. Data collected in the course of this test is not initially intended for release outside of OOI, but will be stored on local servers for later release.

5 Environmental, Health, and Safety Requirements

Environmental, Health, and Safety Requirements as regulated by UNOLS and found within the "Research Vessel Safety Standards", RVSS, 2009 version (www.unols.org/publications/manuals/saf_stand/contents.htm) will be followed.

All science members shall participate in the pre-cruise safety orientation covering location and usage of lifesaving devices per Section 4.2.1 Safety Orientation of the RVSS.

Safety equipment such as lifejacket and hardhats shall be used while working on deck per the Chapter 1 of the Safety Training Manual prepared by the Research Vessel Operators Committee.

All working rope and cable safe working load standards per Appendix A UNOLS Rope and Cable Safe Working Load Standards.

Specific safe load limits (for rope, cables and general ship board equipment) shall be used based on the equipment limits of the vessels used as stated in their Cruise Planning Manuals.

All lifting and cargo straps will be inspected prior to use and will be verified as meeting loads with applicable safety limits by trained, experienced personnel.
Batteries used in this test are lithium primary type, and are not reusable. The activities covered in this test plan are not designed to completely exhaust the battery packs, so battery disposal should not be necessary. If battery disposal is required, it will be in accordance with policies of the Woods Hole Oceanographic Institute or Oregon State University Waste Pickup System, depending on the location where disposal is performed. TWR has obtained DOT approval to ship gliders with the battery packs installed provided (a) the red (off) shorting plug is installed in the glider's tail and (b) the glider shipping container is labeled and shipped as hazardous material.

The glider vendor will supply instructions for the safe handling, installation, and removal of the lithium battery packs.

6 Test Team Organization and Responsibilities

Name	OOI title	Roles and responsibilities
Ed Dever	Endurance Systems Engineer	oversight of all operations, plans, and procedures test director
Jack Barth	Project Scientist	chief scientist at sea, Oregon
Al Plueddeman	Project Scientist	Analysis of PVT results
David Neiman	CGSN I&V/Test Engineer	Test conductor
Chris Holm	Field technician	Field party chief, west coast testing
Craig Risien	EPE liaison	Photo and video documentation
John Lund	WHOI/OOI Field Engineer	Field party chief, east coast testing
One to two of John Dingess, Chris DeCollibus and Ben Allsup	TWR representative	Support glider operations during test deployments

7 Test Schedule

A schedule of activities is given below:

Activity	Date
Test plan (rev 1-00) review and release	7/20/2011
Test plan (rev 2-00) CCB	9/28/2011
Factory Acceptance Test Sign-off	10/4/2011
Glider receipt	10/4/2011
Test Readiness Review	10/7/2011
Review of Dry testing at TWR and/or WHOI (TC-001, 002)	10/8/2011-10/15/2011
Review of Pre-deployment Sheltered-water Testing (TC-003)	10/8/2011-10/15/2011
Deployment toward Atlantic Shelf (appx. 70º55'W) (TC-004)	11/3/2011
Glider arrives at Pioneer 200m isobaths	11/11/2011-11/14/2011 (depends on deployment site)
~200m virtual mooring (TC-005)	11/14/2011 (assume latest expected date)
Glider reaches deep (>1000m) water, 1000m virtual mooring (TC-006)	11/15/2011
Glider travels to recovery point (TC-007)	11/19/2011-11/22/2011 (depending on recovery site)
Glider recovery (TC-007)	11/22/2011 (assume latest expected date)
Glider post-recovery examination (TC-008)	11/22/2011-11/29/2011
Glider packed and shipped to Corvallis	11/29/2011
Glider received in Corvallis	12/13/2011 (assuming 2 weeks ground shipping)
Predeployment testing for Oregon Shelf (TC-009)	12/13/2011-1/4/2012
Deployment along Endurance Newport glider line	1/5/2012

Activity	Date
(TC-010)	
Glider arrives at 1000m depth	1/8/2012
Glider arrives at 126º W	1/12/2012
Glider returns to Newport deployment site	1/12/2011-1/19/2012
Glider recovery (TC-011)	1/19/2012
Post-recovery assessment (TC-012)	1/19/2012-1/26/2012
Quick Look test report	1/26/2012
Final report	2/26/2012

Note that all deployment/recovery dates are contingent on acceptable weather. Use of latest expected dates is an attempt to build in schedule time to account for weather and other delays. A glider abort requiring at-sea intervention may eliminate some test scenarios and require additional personnel and vessel time (up to 200nm round trip for an abort at maximum distance from shore). If an abort situation during the Atlantic Shelf test group prevents the verification of any requirements with “demonstration” verification method, verification can be performed during the Oregon Shelf deployment.

8 Requirements Traceability

An RVCM is attached.

9 Records

Quick-Look Test Reports
"As-run" Test Procedures
RVCM

Table 9-1: Link of Glider Requirement to Test Case (Ver-CG number in parenthesis)

Note: All instrument verifications are part of TC-001, Ver-CG-45

Spec. ID	Requirement ID	Test Case											
		1 (45)	2 (56)	3 (55)	4 (54)	5 (53)	6 (52)	7 (51)	8 (50)	9 (49)	10 (48)	11 (47)	12 (46)
OPEN-001	L4-CG-GD-RQ-167	x											
OPEN-002	L4-CG-GD-RQ-168	x											
OPEN-003	L4-CG-GD-RQ-129				x		x	x			x	x	
OPEN-004	L4-CG-GD-RQ-213	x											
OPEN-005	L4-CG-GD-RQ-130			x									
OPEN-006	L4-CG-GD-RQ-132				x	x		x			x	x	
OPEN-007	L4-CG-GD-RQ-133				x	x		x			x	x	
OPEN-008	L4-CG-GD-RQ-216			x	x			x			x	x	
POWR-001	L4-CG-GD-RQ-126								x				x
POWR-002	L4-CG-GD-RQ-128								x				x
POWR-003	L4-CG-GD-RQ-82								x				x
POWR-004	L4-CG-GD-RQ-76								x				x
POWR-005	L4-CG-GD-RQ-80								x				x
POWR-007	L4-CG-GD-RQ-169	x	x							x			
NAVG-001	L4-CG-GD-RQ-97				x	x	x	x			x	x	
NAVG-002	L4-CG-GD-RQ-104	x											
NAVG-003	L4-CG-GD-RQ-105			x	x	x	x	x			x	x	
NAVG-004	L4-CG-GD-RQ-106		x	x									
NAVG-005	L4-CG-GD-RQ-107	x											
NAVG-006	L4-CG-GD-RQ-108			x	x	x	x	x			x	x	

Spec. ID	Requirement ID	Test Case											
		1 (45)	2 (56)	3 (55)	4 (54)	5 (53)	6 (52)	7 (51)	8 (50)	9 (49)	10 (48)	11 (47)	12 (46)
NAVG-007	L4-CG-GD-RQ-109	x											
NAVG-008	L4-CG-GD-RQ-170	x			x	x	x	x			x	x	
NAVG-009	L4-CG-GD-RQ-171				x						x		
COMS-001	L4-CG-GD-RQ-72	x											
COMS-002	L4-CG-GD-RQ-73	x											
COMS-003	L4-CG-GD-RQ-78				x	x	x	x			x	x	
COMS-004	L4-CG-GD-RQ-79			x	x	x	x	x			x	x	
COMS-005	L4-CG-GD-RQ-90				x	x	x	x			x	x	
COMS-006	L4-CG-GD-RQ-95				x	x	x	x			x	x	
COMS-007	L4-CG-GD-RQ-172		x	x	x			x			x	x	
COMS-008	L4-CG-GD-RQ-96					x	x	x			x	x	
COMS-009	L4-CG-GD-RQ-98				x	x	x	x			x	x	
COMS-010	L4-CG-GD-RQ-173		x	x	x								
COMS-011	L4-CG-GD-RQ-99				x	x	x	x			x	x	
COMS-012	L4-CG-GD-RQ-100				x	x	x	x			x	x	
COMS-013	L4-CG-GD-RQ-101				x	x	x	x			x	x	
COMS-014	L4-CG-GD-RQ-112			x	x	x	x	x			x	x	
COMS-015	L4-CG-GD-RQ-113				x	x	x	x			x	x	
COMS-016	L4-CG-GD-RQ-114			x	x	x	x	x			x	x	
COMS-017	L4-CG-GD-RQ-116				x	x	x	x			x	x	
COMS-018	L4-CG-GD-RQ-117			x	x	x	x	x			x	x	
COMS-019	L4-CG-GD-RQ-120	x											

Spec. ID	Requirement ID	Test Case											
		1 (45)	2 (56)	3 (55)	4 (54)	5 (53)	6 (52)	7 (51)	8 (50)	9 (49)	10 (48)	11 (47)	12 (46)
COMS-020	L4-CG-GD-RQ-121				x			x					
COMS-021	L4-CG-GD-RQ-122						x						
COMS-022	L4-CG-GD-RQ-123		x										
COMS-023	L4-CG-GD-RQ-140		x										
COMS-024	L4-CG-GD-RQ-141	x											
COMS-025	L4-CG-GD-RQ-156				x						x		
SENS-002	L4-CG-GD-RQ-119				x	x	x	x			x	x	
SENS-003	L4-CG-GD-RQ-131	x		x									
SENS-004	L4-CG-GD-RQ-174			x	x	x	x	x			x	x	
SENS-005	L4-CG-GD-RQ-175			x	x	x	x	x			x	x	
SENS-006	L4-CG-GD-RQ-215			x	x	x	x	x			x	x	
SENS-007	L4-CG-GD-RQ-177			x	x	x	x	x			x	x	
SENS-008	L4-CG-GD-RQ-178			x	x	x	x	x			x	x	
DATA-001	L4-CG-GD-RQ-77	x											
DATA-002	L4-CG-GD-RQ-91								x				x
DATA-003	L4-CG-GD-RQ-102			x	x	x	x	x			x	x	
DATA-004	L4-CG-GD-RQ-103	x											
DATA-005	L4-CG-GD-RQ-110	x		x	x	x	x	x			x	x	
DATA-006	L4-CG-GD-RQ-111			x	x	x	x	x			x	x	
DATA-007	L4-CG-GD-RQ-179			x	x	x	x	x			x	x	
OPSM-001	L4-CG-GD-RQ-84	x											
OPSM-002	L4-CG-GD-RQ-85	x											

Spec. ID	Requirement ID	Test Case											
		1 (45)	2 (56)	3 (55)	4 (54)	5 (53)	6 (52)	7 (51)	8 (50)	9 (49)	10 (48)	11 (47)	12 (46)
OPSM-003	L4-CG-GD-RQ-87									x			
OPSM-004	L4-CG-GD-RQ-89	x											
OPSM-005	L4-CG-GD-RQ-180	x											
OPSM-006	L4-CG-GD-RQ-181	x											
OPSM-007	L4-CG-GD-RQ-185	x											
OPSM-008	L4-CG-GD-RQ-186			x									
OPSM-009	L4-CG-GD-RQ-187	x											
OPSM-010	L4-CG-GD-RQ-188	x											
OPSM-011	L4-CG-GD-RQ-189	x											
OPSM-012	L4-CG-GD-RQ-191			x	x	x	x	x			x	x	
OPSM-013	L4-CG-GD-RQ-192		x	x	x	x	x	x			x	x	
OPSM-014	L4-CG-GD-RQ-193		x										
QUAL-003	L4-CG-GD-RQ-74	x											
SHIP-004	L4-CG-GD-RQ-194	x											
SHIP-005	L4-CG-GD-RQ-217	x											
SHIP-006	L4-CG-GD-RQ-195	x											

Appendix A: List of Test Procedures

Test Case ID	Test Case Name	Procedure Document Number
TC-001/Ver-CG-45	Inspection	3617-10101
TC-002/Ver-CG-56	Communications and Dry Tests	3617-10102
TC-003/Ver-CG-55	Pre-deployment Sheltered-water Testing	3617-10103
TC-004/Ver-CG-54	Cross-shelf transit outbound	3617-10104
TC-005/Ver-CG-53	Virtual Mooring to approximately 200m depth	3617-10105
TC-006/Ver-CG-52	Virtual Mooring to 1000m depth	3617-10106
TC-007/Ver-CG-51	Return to Atlantic Shelf recovery point, recovery	3617-10107
TC-008/Ver-CG-50	Poet-recovery Evaluation, Atlantic	3617-10108
TC-009/Ver-CG-49	Pre-deployment Testing, Oregon Shelf	3617-10109
TC-010/Ver-CG-48	Deployment Testing, Oregon Shelf	3617-10110
TC-011/Ver-CG-47	Recovery, Oregon Shelf	3617-10111
TC-012/Ver-CG-46	Poet-recovery Evaluation, Oregon Shelf	3617-10112