



Quick Look Test Report

Document No.: 3167-17002

Test Event Name:		Coastal Glider PVT CG-VE-3098		Test Plan Document No.:	3167-10000	Test Plan Rev.:	2-00	Report Date:	2012-02-27
Test Report Reviewed & Approved By									
Quality Engineer (Print Name)		Signature	Date	Test Director (Print Name) Edward Dever		Signature Edward Dever (in lieu of electronic signature)		Date 2012-03-09	

Test Event Description
 This document refers to Coastal Glider Product Verification Test activities occurring during and after deployment of the glider in the Endurance array area for sea trials. These activities include pre-deployment, sea trial, and recovery. Also included is the post-recovery analysis of data and power usage. Details of verification of individual requirements are found in DCN 3167-10109 (Ver-CG-49), 3167-10110 (Ver-CG-48), 3167-10111 (Ver-CG-47) and 3167-10112 (Ver-CG-46).

Test Results					
Test Case ID	Test Name / Description	Test Results / Data	Test Conclusions	Corrective Action	Requirement ID
TC-009, Ver-CG-49	VE-CG-3098 Predeployment testing, Oregon Shelf	Forward batteries and buoyancy engine were removed and refitted.	The battery and buoyancy engine refits were successful. That and TWR glider history shows that the glider can be redeployed following refurbishment and refueling.	none	L4-CG-GD-RQ-87
TC-010, Ver-CG-48	VE-CG-3098 Deployment, Oregon Shelf	The glider was successfully deployed from the R/V Pacific Storm and again from the R/V Miss Linda.	The glider can be deployed from two different vessels that are probably going to be used for OOI glider operations.	none	L4-CG-GD-RQ-216
TC-010, Ver-CG-48	VE-CG-3098 Deployment, Oregon Shelf	Glider average speed in specified conditions was >35cm/s.	The glider forward speed requirement was met under conditions consistent with science and endurance objectives.	none	L4-CG-GD-RQ-171
TC-010, Ver-CG-48	VE-CG-3098 Deployment, Oregon Shelf	During the Oregon shelf deployment, the glider the glider successfully completed 50 dives to 1000m.	The objectives of this requirement are met. See note 1.	none	L4-CG-GD-RQ-129
TC-010, Ver-CG-48	VE-CG-3098 Deployment, Oregon Shelf	Artifacts were produced to show compliance with Freewave course control requirements	Freewave control of glider trajectory has been successfully demonstrated and documented.	none	L4-CG-GD-RQ-172
TC-011, Ver-CG-47	VE-CG-3098 Recovery, Oregon Shelf	The glider was recovered 1/13/2012 (R/V Elakha, conventional recovery), 1/30/2012 (R/V Pacific Storm, nose-recovery used) 2/21/2012 (R/V Miss Linda, nose recovery)	Recovery to archetypal vessels can be performed without special boat fittings.	none	L4-CG-GD-RQ-216

Test Results					
Test Case ID	Test Name / Description	Test Results / Data	Test Conclusions	Corrective Action	Requirement ID
TC-012, Ver-CG-46	VE-CG-3098 Post-recovery Evaluation, Oregon Shelf	During the 9-day Endurance deployment, the glider produced 123.7MB of engineering data and 86.1MB of science data (including decimated files).	The 2GB CF card on the engineering computer can store the expected data generated by a 90-day deployment. The 2GB CF card on the science computer can store the expected data generated by a 90-day deployment.	none	L4-CG-GD- RQ-91
TC-012, Ver-CG-46	VE-CG-3098 Post-recovery Evaluation, Oregon Shelf	Average power consumption during operation in water >1000m deep was 0.3017A.	For the battery capacity fitted to the OOI Coastal Glider, average power consumption to meet the 90- day requirement is .3167A. For deep water operation with OOI default sensor usage and normal telemetry (per test conditions), the glider can achieve the required endurance.	none	L4-CG-GD- RQ-126
TC-012, Ver-CG-46	VE-CG-3098 Post-recovery Evaluation, Oregon Shelf	Using the 35cm/s speed demonstrated in TC-010, a conservative 15minutes/3 hour telemetry time, and 90-day endurance for operation to 1000m, the calculated glider range is ~2500km.	The glider can achieve the required 1800km range in a 90-day deployment. During a 60-day deployment, the expected range is ~1650km.	none	L4-CG-GD- RQ-128
TC-012, Ver-CG-46	VE-CG-3098 Post-recovery Evaluation, Oregon Shelf	An analysis of the power required to operate the glider per OOI requirements is presented in the results for TC-012, and indicates an emergency-power duration of 64 days.	The requirement for 60 day operation is met by the glider.	none	L4-CG-GD- RQ-76
TC-012, Ver-CG-46	VE-CG-3098 Post-recovery Evaluation, Oregon Shelf	Endurance flight testing for the glider in >1000m deep water (2/15-21/2012) indicates that 90-day operation with OOI default sampling would consume 652A-h. This analysis is conditional on operation of the glider in >1000m depth.	The internal battery capacity is 720A-h, including derating for the expected 10 °C average temperature. 5% (36A-h) is kept as a reserve for requirement L4- CG-GD-RQ-76, leaving 684A-h available. The glider can finish a 90-day deployment using only onboard power	none	L4-CG-GD- RQ-82
TC-004 Ver-CG-54	VE-CG-3098 Cross-shelf transit outbound	For the conditions used in the Endurance test deployment, experimental data for battery life agree with the TWR model to within 10% for dive depths >~600m.	The model is acceptable for the 1000m engine.	none	L4-CG-GD- RQ-90

Notes:

- 1) During the first deployment the glider required recovery and reballasting before attempting a 1000m dive. During the second deployment, a ballast pump failure occurred prior to reaching 1000m water. See the attached TWR KB3223 (Figure 1) for details of the failure and its resolution.

		KNOWLEDGE BRIEF CORRECTIVE ACTION REPORT		#KB-3223		REVISION: 2/29/2012 STATUS: OPEN										
BUSINESS UNIT: E&I-HOS		SUBJECT: Failed Buoyancy Pump on Glider 247		PRODUCT LINE: Webb Research PRODUCTS: Glider ITAR: n/a		PROPRIETARY <small>This document contains information that is the property of Teledyne Technologies, Inc. and is intended for the use of the customer. It is not to be distributed outside the organization without the prior written consent of Teledyne Technologies, Inc.</small>										
AUTHOR: Shawn Green		DATE OPENED: 2/7/2012		REVIEWER: Bill Wicler		DATE CLOSED: [Date Closed]										
ACCESS:																
Closed & Verified: Reviewer: _____ Date: _____ QA: _____ Date: _____																
PROBLEM DESCRIPTION:																
<p>Unit 247 (OO1) failed in the field on January 25th off the coast of Oregon. The buoyancy pump failed on two occasions during the deployment, once soon after deployment at which time the pump stopped moving oil to the external bladder at about -160cc on a climb from a depth of about 60 meters, and subsequently retracted when the glider determined that it was stuck moving vertically, then remained retracted and unable to pump out until the glider aborted the mission, when it did begin to pump out and the glider surfaced.</p> <p>The second incident occurred later the same day, this time the pump stopped working at a similar place in the climb and also sat on the bottom until it aborted the mission, but this time the pump did not function and the glider sat on the bottom until the ejection weight was jettisoned.</p>																
CONTAINMENT PLAN:																
1) On 2/9/12, inspected all Gliders in WIP to make sure the set screw shows the presence of Red Loctite. No problems found. (complete)																
2) On 2/9/12, inspected (3) Pump Assy's (G-710) to make sure the set screw shows the presence of Red Loctite. No problem found. (complete)																
3) On 2/9/12, verified that the Pump Assembly Procedure (2446-AP) says to use Red Loctite (step 1 on page 3) on the Set Screw. (complete)																
4) On 2/10/12, inspected (11) Motor Assy's (G-942), (8) are good, and (3) are questionable. The three that are questionable were re-locked and now are good. (complete)																
<table border="0"> <thead> <tr> <th>Actionee:</th> <th>Due Date:</th> <th>Status:</th> </tr> </thead> <tbody> <tr> <td>Shawn Green</td> <td>2/16/12</td> <td>Closed</td> </tr> <tr> <td>Ardale Chevalier</td> <td></td> <td></td> </tr> </tbody> </table>								Actionee:	Due Date:	Status:	Shawn Green	2/16/12	Closed	Ardale Chevalier		
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ROOT CAUSE:
 Initial inspection of the unit showed no visible damage to the pump or the oil tubing, and no visible oil in the crd cap. The motor controller circuit board is undamaged and connected properly. The oil reservoir potentiometer is secure and connected properly.
 The Berg coupler (G-912) on the motor end of the coupling was not secure to the motor shaft (see picture below). The set screw was in place, but the coupler spun on the shaft. The set screw appears worn on the top where it has rubbed against the motor shaft as it spun. The motor shaft does have an imprint on the flat face of the shaft that appears to suggest that the set screw was properly tightened initially, but loosened in service.

The set screw does not appear to have had any Red Loctite applied to it. It was easily removable with light force.

CORRECTIVE ACTION PLAN:

- 1) The team at OSU removed the forward section of the glider and shipped it to TWR for evaluation and repair. The assembly arrived on Friday February 3rd. Repaired and sent back to the customer. **(complete)**
- 2) On 2/9/12, communicated to the Glider Assembly Operators to use Red Loctite on the Set Screw of Pump Assembly per Procedure (2446-AP). **(complete)**

Actionee:	Due Date:	Status:
Shawn Green	2/29/12	Closed

PREVENTIVE ACTION PLAN:

- 1) Investigate Pre-Loctited Set Screws or Nylok Set Screws, if available, then the Pre-Loctited Set Screws or Nylok Set Screws will be tested and if successful they will be implemented.
- 2) Investigate a torque requirement for the Set Screw.

Actionee:	Due Date:	Status:
Shawn Green	3/30/12	Open
Bill Hurley		

VERIFICATION:

- 1) Monitor production for the presence of Red Loctite on the Set Screw of the Pump Assembly G-710.
- 2) Interface with TWR Customer Service to monitor customer complaints for this Buoyancy Pump failure mode.

Figure 1: TWR Knowledge Brief 3223 (failure analysis report and corrective actions) for ballast pump failure during Endurance deployment.