Engineering Change Request Form

Change Request No.:	Date:	WBS:
1300-00318	11/30/2012	

Control Account Name: None	Configuration Manager: Griffin, Emily	Control Account Manager:

SECTION TO BE COMPLETED BY PERSON REQUESTING CHANGE:		

Requestor: Sheri White	Telephone Number: (508) 289-3740

Request Name (Include document number and revision level):
FDCLP/HP Name Change, Requirements Waiver and Modification, and Conversion from Buy to Make

Description of Change (Include all related systems):
This ECR changes an instrument five letter class name, requests a requirements waiver, requests a reduction in instrument numbers, and changes the acquisition approach from Buy to Make

(See attached document 1300-00318_FDC_ECR_Detail_2012-11-30_ver1-04.docx for complete text and tables)

Name Change:
The proposed name change is from the existing FDCLP/HP to FDCHP.

Reducing FDCLP/HP at Selected Sites:
According to the Instrument Application in the Software Application Framework and the CGSN Reference Designator Spreadsheet (3102-00008), FDCLP/HP are required on surface buoys at each of ten sites, including three Global sites (Irminger Sea, Southern Ocean, and Argentine Basin), three sites in the Pioneer Array, and four sites in the Endurance Array (two on the Oregon line and two on the Washington line). One Construction unit and one O&M unit are needed for each site. The CGSN instrument spares spreadsheet (3305-00020) calls for four FDCLP/HP Spares: one Spare for the Pioneer Array, one Spare for the Endurance Array, one Global Spare for the Argentine Basin Array, and one Global Spare for the Irminger Sea and Southern Ocean Arrays. Half the spares are to be procured under Construction and half under O&M.
The number of FDCLP/HP is proposed to be reduced by removing FDCLP/HP from the Argentine Basin site, two of the three sites at the Pioneer Array, and three of the sites at the Endurance Array, as indicated in Table 1. One spare is proposed to be produced under Construction (Table 1) and two under O&M.

Waiving Requirements Associated with Turbulent Humidity Measurements:
All requirements associated with turbulent humidity measurements and moisture fluxes are proposed to be waived or partially waived. The details for the L2, L3 and L4 requirements are shown in Tables 2, 3 and 4.

Change from Buy to Make:
The acquisition of FDCLP/HP is proposed to change from Buy to Make.
Production of the required FDCLP/HP units will be based on an existing Direct Covariance Flux Sensor (DCFS), which has been developed for scientific use by Jon Ware at the Woods Hole Oceanographic Institution (WHOI) under the direction of Jim Edson, now at the University of Connecticut (UConn). The DCFS consists of a sonic anemometer, which provides high-frequency (20 Hz) measurements of the three dimensional velocity vector and the sonic temperature within the sample volume; a three-axis compass, which serves as a low frequency reference and provide the wind and stress directions; and a motion package, sampled coherently with the sonic anemometer measurements. These measurements are analyzed in post-processing to remove artifacts of platform motion and produce direct estimates of the air-sea fluxes of momentum and sonic temperature. The DCFS does not distinguish between high- and low-power units. The current estimate of the power requirement while on is 6 W. The standard DCFS is capable of duty cycling. The DCFS meets the proposed revised CGSN requirements (i.e. without turbulent humidity and moisture flux measurements, as shown in Tables 2-4), except that it is not capable of onboard processing and does not produce processed data in near real time. To meet the revised CGSN requirement, the existing DCFS instrument developed by Ware and Edson will need to be upgraded. The instruments will be constructed by Ware at WHOI under the direction of a WHOI CGSN Systems Engineer with Edson as a Subject Matter Expert (SME). The Non-Recurring Engineering (NRE) for the First Article will include incorporation of a faster on-board processor and implementation of on-board processing and near-real-time delivery of processed data. Ware will work with the CGSN Systems Engineer and will confer with Lead Electrical Engineer and Software Engineer Steve Holford to ensure that the new DCFS on-board processor will communicate as required with the Platform software. The First Article will be tested on small boat deployments off Woods Hole. Ware will charge OOI charge numbers at WHOI for this work. Edson will be supported through a WHOI subcontract.

Cost Estimate:
The cost estimate is summarized in Table 5. The Basis of Estimate (BOE) for Systems Engineering (SE) for the First Article is in the attached spreadsheet (1300-00318_FDC_SE_BOE_2012-11-16_ver_1-01.xlsx). The BOE for all other

costs is in the attached WHOI budget (1300-00318_17997.00_FDC_Budget_2012-11-30.pdf).

Budget Transfers between Control Accounts and Creating Two New Control Accounts:
The required Budget transfers between Control Accounts are summarized in Table 6. Also shown in Table 6 is creation of two new Control Accounts. The detailed Work Breakdown Structure elements will be finalized once the ECR is approved.

Risk:
This ECR will mitigate Risk 3086, entitled "Direct Flux Covariance Instrument Procurement," which states that if no proposals are received for the direct flux covariance instrument, then the costs to the project will increase due to no Commercial off the Shelf (COTS) solution being available, requiring NRE. This risk was estimated at a likelihood of 95% with a consequence value of $125,000 for an exposure value of $118,750. This risk and its exposure value will be completely retired when this ECR is approved.

Science Impact:
The science products of the FDCLP/HP are direct covariance measurements of the turbulent air-sea momentum flux, sensible heat flux, and humidity flux, from which the latent heat flux can be calculated using established thermodynamic relationships. Here flux means transport rate and the turbulent air-sea momentum flux is equal to the wind stress on the ocean surface.
Fluxes from the FDCLP/HP are direct and in that sense superior to the indirect estimates of the same fluxes from the METBK, which are derived via empirical formulas from measurements of the temporally averaged (i.e. non-turbulent) air-sea velocity and temperature differences and the temporally averaged atmospheric humidity. The empirical METBK formulas are well established under moderate conditions, for which extensive calibration data are available, but are more uncertain under extreme conditions, for which calibration data are limited. METBK is required on all ten platforms where FDCLP/HP is required. Where both measurements are available, the FDCLP/HP measurements can be used to extend and refine the empirical basis for the METBK formulas, which is particularly important under extreme conditions. Where direct covariance measurements are not available, the indirect METBK values can be used to estimate air-sea fluxes.
The proposed upgraded DCFS will produce direct covariance measurements of the turbulent momentum flux, but, instead of direct covariance measurements of the fluxes related to heat and humidity, the DCFS will produce direct covariance measurements of the turbulent buoyancy flux. The turbulent buoyancy flux is dynamically important in its own right, but differs from and contains less information than the fluxes produced by the FDCLP/HP. Thus the DCFS produces some but not all of the turbulent flux information required from the FDCLP/HP.
The consensus of the CGSN Project Scientists is that waiver of the requirement for turbulent humidity measurements is necessary given the state of the technology, and that the reduced set of fluxes from the DCFS relative to the FDCLP/HP, and the reduction in the number of sites, are acceptable because of the ability to supplement indirect estimates based on METBK measurements can supplement the direct flux measurements provided by the DCFS. Sites where extreme forcing is expected (Irminger Sea and Southern Ocean) and coastal sites where the air-sea interaction might be complicated because of fetch limitations and other complications (the Pioneer and Endurance sites) have been selected for the reduced set of four FDCLP/HP.

Reason for Change:
Name Change:
The reason for the proposed name change is that while the 2009 plan and budget for CGSN assumed two types of Direct Covariance Flux Sensors, designated FDCLP and FDCHP for Flux Direct Covariance Low Power and High Power, the present requirements do not distinguish between the two types, and FDCLP and FDCHP are now synonymous. Use of the proposed FDCHP will be simpler.

Removing FDCLP/HP at Selected Sites:
The proposed removal of FDCLP/HP at selected sites as shown in Table 1 is requested in order to keep Construction costs within the existing Budget.

Waiving Requirements Associated with Turbulent Humidity Measurements:
The reason for the proposed waiver of all requirements associated with turbulent humidity measurements is that no COTS sensor is capable of producing a turbulent humidity measurement within the required power budget. Requirement L4-CG-IP-RQ-657 states that the power consumption of the direct covariance flux instrument package shall not exceed 20 Watts when continuously powered. LI-COR, Incorporated, manufactures a closed-path infrared gas analyzer (IRGA), which is capable of turbulent humidity measurements. Current information indicates that the IRGA draws approximately 20 Watts by itself, so that a direct covariance flux instrument including the IRGA plus other components would not meet the power requirement.

Change from Buy to Make:
The reason for the proposed change from buy to make is that no vendors responded to the Request for Proposals (RFP) #07-29-2011 for the FDCLP/HP, which was released on July 31, 2011, with a closing date on August 26, 2011.

Budget Transfers between Control Accounts:
The proposed budget transfers between Control Accounts are required in order to charge the required work to the proper Control Accounts without overruns.

Benefit to OOI:
The proposed actions will produce direct covariance measurements of the air-sea momentum and buoyancy fluxes within the existing Construction budget at selected key sites with acceptable science impact.

Requestor Assessment of Impact to Control Account:

Scope:
The proposed change will reduce scope by eliminating the turbulent humidity measurement and reducing the number of sites. The science impact is judged acceptable by the CGSN Project Scientists as noted above.

Schedule:
The existing CGSN deployment schedule will not be impacted. The first FDCHP units will be deployed in 2014 at the Pioneer site.

Cost:
The estimated cost is within the existing Construction Budget.

SECTION TO BE COMPLETED BY IO/SL CCB CHAIRPERSON:

Assessment of Impact to IO Project:

Master Schedule:
The IMS will need to be updated to reflect the instrument five letter class name change, but it will not impact the schedule.

Project Cost:
no change

Deliverables:
no change

Potential Impact to Science and Design / As-built Capability: The consensus of the CGSN Project Scientists is that waiver of the requirement for turbulent humidity measurements is necessary given the state of the technology, and that the reduced set of fluxes from the DCFS relative to the FDCLP/HP, and the reduction in the number of sites, are acceptable because of the ability to supplement indirect estimates based on METBK measurements can supplement the direct flux measurements provided by the DCFS. Sites where extreme forcing is expected (Irminger Sea and Southern Ocean) and coastal sites where the air-sea interaction might be complicated because of fetch limitations and other complications (the Pioneer and Endurance sites) have been selected for the reduced set of four FDCLP/HP. Thus, while the OOI science is impacted by the waiver, it is not a significant change and due to the current state of technology there is no other alternative.

Additionally, this ECR reduces the number of deployed instruments from 10 to 4. This obviously will impact the data provided by OOI. However, there are METBK instruments co-located with each of the 10 DCFS instruments. Flux measurements from METBK are derived via empirical formulas from measurements of the temporally averaged (i.e. non-turbulent) air-sea velocity and temperature differences and the temporally averaged atmospheric humidity. The empirical METBK formulas are well established under moderate conditions, for which extensive calibration data are available, but are more uncertain under extreme conditions, for which calibration data are limited. Where both measurements are available, the DCFS measurements can be used to extend and refine the empirical basis for the METBK formulas, which is particularly important under extreme conditions. Where direct covariance measurements are not available, the indirect METBK values can be used to estimate air-sea fluxes.

Percent Impact on WBS elements(s) selected: 0%		Percent Impact on OOI: 0%	
Contingency $0		**Contingency Schedule (weeks):** 0	
Signature of System CCB Chairperson: Ed Chapman (echapman@oceanleadership.org)	**Date:** 12/11/2012 2:00:00 PM		**Board Determination:** Approved
Signature of NSF CCB Chairperson: Jean McGovern (jmcgover@nsf.gov)	**Date:** 12/21/2012 1:00:00 PM		**Board Determination:** Approved with Liens
CERTIFICATION OF TECHNICAL DATA PACKAGE AND CONTROL SYSTEM UPDATE			
Signature of Configuration Manager: Emily Griffin (egriffin@oceanleadership.org)	**Date:** 8/28/2013 10:31:37 AM		**Systems and Documentation Updated:** Confirmed Complete

Attach supporting technical documentation and or additional comments as needed.

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ECR Comments						
#	Reviewer	Date Added	General Comment	Requestor Response	CCB Decision	Lien
1	Kathy Carr	12/3/2012	As an administrative action, the B2 table Instrument Classes tab should be updated to remove FDCLP.	Accept		
2	Al Plueddemann	12/7/2012	Recommend approval.			
3	Ed Chapman	12/7/2012	I recommend approval.			
4	Michael Zernick	12/7/2012	No additionalcomments.			
5	Susan Banahan	12/10/2012	Recommend approval.			
6	Michael Vardaro	12/10/2012	Reviewed. Recommend approval.			
7	John Orcutt	12/10/2012	The risk that there was no commercial instrument available has been known for some time. While the source risk will be retired, it would appear that the construction of an operational sensor with minimal time, represents a new risk of some substance.	Reject		
8	Sheri White	12/11/2012	A number of artifacts will need to be updated to reflect the change in instrument class (FDCLP to FDCHP): Instrument Application in the SAF, 3102-00008, 3102-00011, 3305-00020. Updates to these artifacts should be set as Administrative Actions.	Accept		
9	Sheri White	12/11/2012	Risk 3545 Flux_direct_cov_HP Calibration also needs to be retired per this ECR. This risk states "If the Direct Covariance Flux sensor – high power version cannot maintain calibration for the full deployment period due to environmental contamination of the IR gas analyzer, then Level 4 requirements for sensor accuracy will not be met.". A Risk Note from Nov 8, 2012 states "The reduction in scope that will be requested in the ECR for the Direct Covariance Flux Sensors (described in risk item 3086) will include a request to eliminate the IR gas analyzer, because no commercially available unit meets the power requirements. If/when the ECR is approved, the corresponding calibration risk will be retired."	Accept		
10	Emily Griffin	1/2/2013	NSF: The reduction in units should address the planned deployment schedule. OL shall create a "rescoping list" for the reduced number of units and consider contingency usage in the future to rescope the units by science priority. Final observatory delivery should be documented at commissioning.		Accept	Yes

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ECR Vote (Highest Level Board: NSF)				
Title	Member Name	Delegate Name	Vote	Comment
Associate Program Director	Susan Banahan		(Did Not Vote)	
Chief Systems Engineer	Ed Chapman		(Did Not Vote)	
OOI Program Director/PI	Tim Cowles		(Did Not Vote)	
Senior Project Manager, Advisor	Anthony Ferlaino		(Did Not Vote)	
NSF Program Director	Jean McGovern		Approve w. Liens	
COTR - Associate Project Manager CI	Bill Pritchett		(Did Not Vote)	

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ECR Liens/Action Items

Lien	Due Date	Complete	Completion Date
NSF: The reduction in units should address the planned deployment schedule. OL shall create a "rescoping list" for the reduced number of units and consider contingency usage in the future to rescope the units by science priority. Final observatory delivery should be documented at commissioning.	1/9/2013	Yes	3/8/2013

Action Item	Due Date	Complete	Cancel	Completion Date
Update SAF Instrument Application to reflect changes.	12/18/2012	Yes	No	3/8/2013
Update B2 Table	12/18/2012	No	Yes	
Mark the Verification Status for the L2 requirements as "Waived" in DOORS.	1/21/2013	Yes	No	1/2/2013
Mark the Verification Status for the L3 requirements as "Waived" in DOORS.	1/21/2013	Yes	No	1/2/2013
Mark the Verification Status for the L4 requirements as "Waived" in DOORS.	1/21/2013	Yes	No	1/2/2013
Update "Approved Waiver-CM" attribute for affected L2 requirement(s) in DOORS with the ECR number of the approved Waiver.	1/21/2013	Yes	No	1/2/2013
Update "Approved Waiver-CM" attribute for affected L3 requirement(s) in DOORS with the ECR number of the approved Waiver.	1/21/2013	Yes	No	1/2/2013
Update "Approved Waiver-CM" attribute for affected L4 requirement(s) in DOORS with the ECR number of the approved Waiver.	1/21/2013	Yes	No	1/2/2013
Update the Verification Details for the L2 requirement(s) with a description of the affected product and an indication of the circumstances under which the requirement has been waived.	1/21/2013	Yes	No	1/2/2013
Update the Verification Details for the L3 requirement(s) with a description of the affected product and an indication of the circumstances under which the requirement has been waived.	1/21/2013	Yes	No	1/2/2013
Update the Verification Details for the L4 requirement(s) with a description of the affected product and an indication of the circumstances under which the requirement has been waived.	1/21/2013	Yes	No	1/2/2013
Baseline L2 Science Requirements module	1/16/2013	Yes	No	1/2/2013
Baseline L3 CG System Requirements module	1/16/2013	Yes	No	1/2/2013
Baseline L4 CG Instrument Package module	1/16/2013	Yes	No	1/2/2013
Export updated L2 Science Requirements spreadsheet and post in Alfresco	1/16/2013	Yes	No	1/2/2013
Export updated L3 CG System Requirements spreadsheet and post in Alfresco	1/16/2013	Yes	No	1/2/2013
Export updated L4 CG Instrument Package spreadsheet and post in Alfresco	1/16/2013	Yes	No	1/2/2013
Coordinate schedule adjustments with Cobra (Vitucci)	5/6/2013	Yes	No	6/17/2013
Implement changes in IMS file(s) (Wiley)	5/6/2013	Yes	No	8/28/2013

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ECR Meeting Results and Notes				
Board Level	Meeting Date	Meeting Name	Meeting Result	Meeting Notes
System	12/11/2012	2012-12-11 System Level CCB	Approved	
NSF	12/21/2012	2012-12-21 NSF CCB	Approved with Liens	The rescoping list requested by NSF is maintained in Confluence. https://confluence.oceanobservatories.org/display/ENG/Re-Scope++Items