Proposal for a Conceptual Study of a Real-Time Mooring Including numerical simulations of the Behavior of the System in the Atlantic Environment

Rev. MAY10 Final

1.0 **Introduction.**

MBARI proposes to the Institut Français de Recherche Pour L'exploitation de la Mer (the French Institute for the Exploitation of the Sea or IFREMER) to provide a conceptual study of a mooring system with a direct connection through the anchor cable to the seafloor (using electro-mechanical (EM) or electro-optical-mechanical (EOM) cable). The purpose of the mooring system is to provide power to seafloor instruments and return data in real time from the seafloor using line-of-sight radio or satellite telemetry communications.

The conceptual design work proposed includes calculation of the mooring surface float size, the weights and balances of the surface float including the bridle and tower, and the calculation of buoyancy, righting moment and static loads. We will complete a numerical simulation of the mooring system dynamic loads using environmental data for significant wave height and ocean currents. Based on the results of the dynamic simulation we will recommend mooring cable designs, mooring deployment methods and predict the cable loads during installation and operation.

A general illustration of the real time mooring system is shown in figure 1 below. The system concept design would include the equipment shown in the illustration and consist of the surface mooring, a riser cable and a subsurface float and anchor assembly.

2.0 **Project schedule.** The concept design study will be completed and submitted to IFREMER no later than October 1, 2010.

3.0 **Technical plan detail.** The specific details of the technical plan for the concept design study are described below.

4.0 **Numerical simulation and mooring configuration design.**

4.1 Andy Hamilton at MBARI will conduct a time domain numerical simulation of the mooring response to wave and current forcing and predict the static and dynamic loads on the riser cable using the modeling program WHOI cable. This work will include modeling the anticipated loads, specifying the construction and the length of the anchor cable ("scope"), specifying the volume of the surface float, specifying the number, type and location of any required intermediate cable floats and specifying the weight and construction of the anchor and anchor float.

4.2 IFREMER will provide the approximate site location coordinates, water depth and a 10 year record of environmental data for the site. This data will include a time series of surface currents, surface winds, and significant wave heights. If IFREMER cannot produce the required environmental data MBARI can procure it from OceanWeather http://www.oceanweather.com/metocean/ for an additional estimated cost of $2300. This information must be available by August 2, 2010 to meet the proposed October schedule.

4.3 IFREMER will provide a total payload weight for the surface mooring to allow specification of the system buoyancy and modeling of the dynamic performance. The payload is specified in mass and height relative to the water line. If the total surface float payload is over 1500 kg then there should be further discussion between IFREMER and MBARI on the methods of analysis. The payload information will need to be provided by August 2, 2010 to meet the proposed October schedule.

5.0 Recommendations for qualification of critical mooring components.

5.1 **EOM or EM anchor cable.** MBARI will describe the mechanical bending stress qualification procedure used for fatigue testing mooring cables and recommend methods to be used for qualifying cables from alternate vendors.

5.2 **Additional critical components for qualification.** Based on MBARI's experience deploying observatory moorings, MBARI will provide recommendations for design studies and qualification tests for the following critical mooring components:

- 5.2.1 EM or EOM cable termination.
- 5.2.2 Cable floats and attachment hardware.
- 5.2.3 Upper and lower strain reliefs.
- 5.2.4 The mooring cable strain relief assembly, or "Snubber".
- 5.2.5 The cable assemblies that connect the seafloor mooring controller at the base of the anchor with the seafloor instrument packages.
- 5.2.6 The material and size for connection shackles and chains.
- 5.2.7 System design for ROV installation

6.0 Presentation of concept design and numerical modeling results.

6.1 The results of the concept design and numerical simulation studies and recommendations for further detailed design studies of critical mooring subsystems will be presented in Brest France in October 2010.

7.0 Resource estimates.

7.1 **Andy Hamilton four weeks**: Dynamic modeling of mooring loads during specified environmental conditions, calculation of deployment loads. Presentation of results in Brest, France.

7.2 **Mark Chaffey one week:** Recommendations for qualification of critical

components. Design of the Snubber bending strain relief elements. Design of the cable terminations.

8.0 **Proposal Costs.** Total proposal cost**: $40,302**

8.1 **Personnel subtotal:**

8.1.1 Andy Hamilton – Four weeks dynamic simulation, one week travel: Salary: $12,420

8.1.2 Mark Chaffey – One week: Salary $3,126

8.1.3 Fringe Benefits – $8,084

8.2 **Travel subtotal. Andy Hamilton**

8.2.1 Travel from San Francisco to Brest France for 5 days, total: $3,060

8.2.1.1 Airfare = $1500

8.2.1.2 Car fare = $60

8.2.1.3 Hotel in Brest = $750

8.2.1.4 Train = $150

8.2.1.5 Meals = $600

8.3 **Overhead Costs:**

8.3.1 Indirect Cost calculated at 51% of Modified Total Direct Cost: $13,612. The base excludes capital items, participant support costs, and subcontract costs exceeding the first 25K of each subcontract.

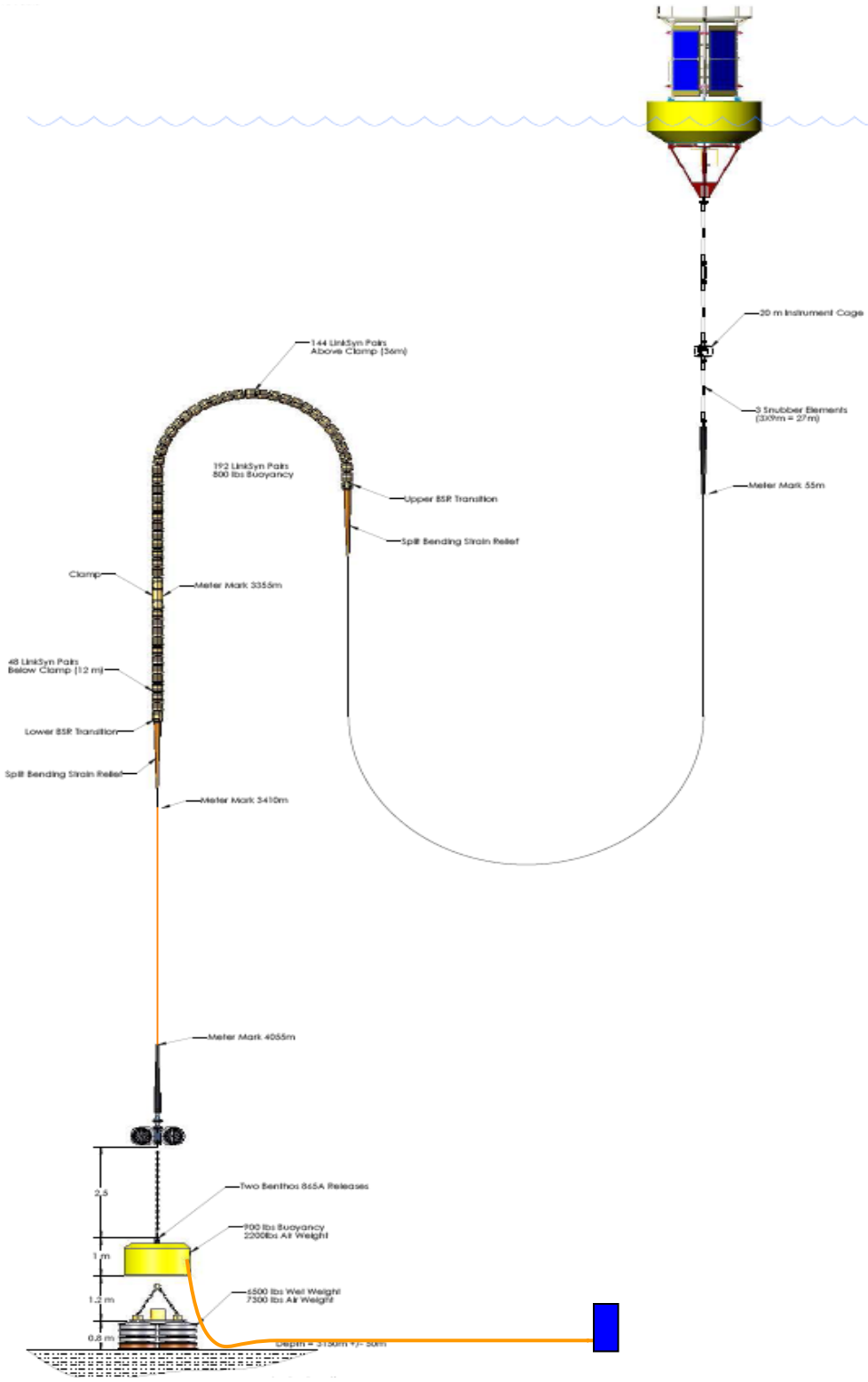

Fig. 1. Proposed mooring configuration for conceptual design and numerical simulation.