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A Deep Sea Docking Station for ODYSSEY Class Autonomous Underwater Vehicles

by

M. F. Bowen, D. B. Peters

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

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Technical Report

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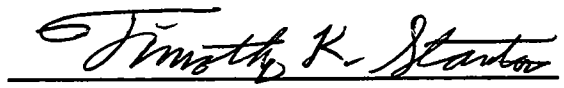

Dr. Timothy K. Stanton

Department of Applied Ocean Physics and Engineering

A Deep Sea Docking Station for ODYSSEY Class Autonomous Underwater Vehicles

Electro-Mechanical Design, Fabrication and Operation for the MIT Sea Grant Autonomous Ocean Sampling Network (AOSN)

Prepared By:
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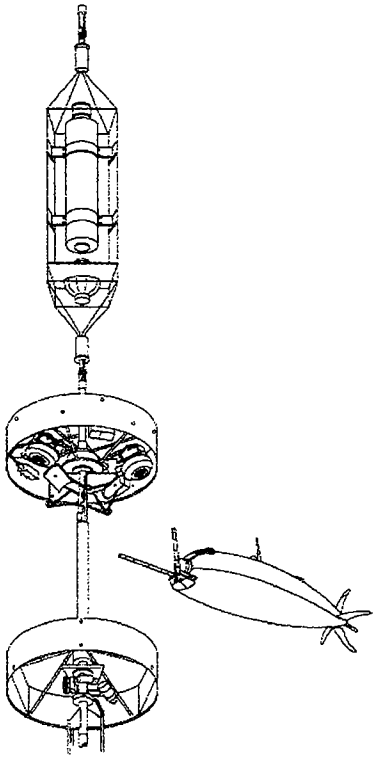

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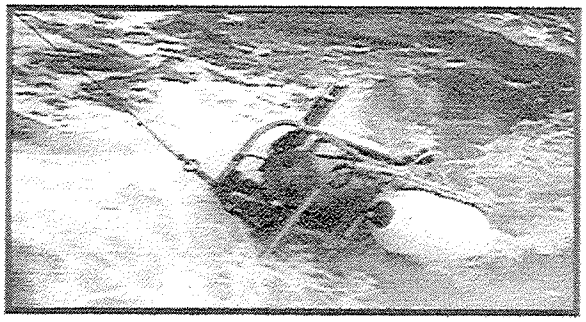

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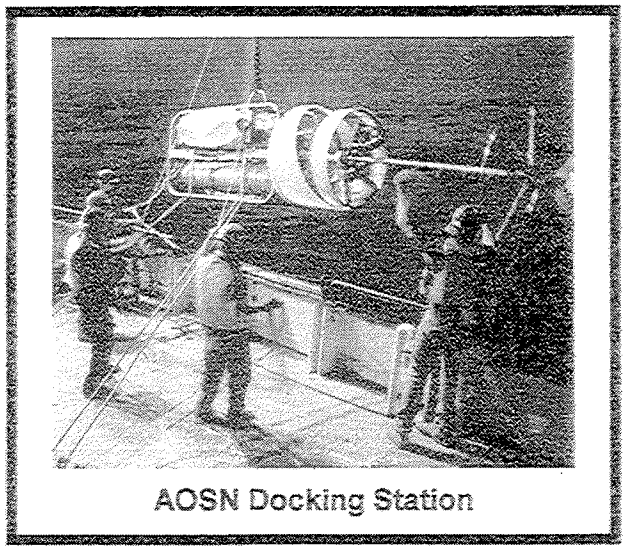


AOSN Docking Station

Abstract

Under subcontract to the Massachusetts Institute of Technology's (MIT) Sea Grant Autonomous Ocean Sampling Network (AOSN) program, engineers and researchers at the Woods Hole Oceanographic Institution (WHOI) designed, fabricated and operated a deep sea Docking Station for ODYSSEY-class autonomous underwater vehicles (AUVs). The docking station provides shelter as well as power transfer and data exchange services for an AUV that is between autonomous midwater missions. The Station is integrated into the main tension member of a deep sea mooring system. A large subsea flotation sphere supports the mass of the Station above the seafloor. A surface expression connected by an umbilical to the Station was capable of bi-directional satellite or radio frequency communications. Primary subsystems of the docking Station described in this report include a dock controller with multi-sensor support, long-duration battery packs, a docking pole with a moving carriage, an inductive link for power and data transfer, and information about how the Station was deployed, operated and recovered. (159) Keywords: AUV, docking, mooring.

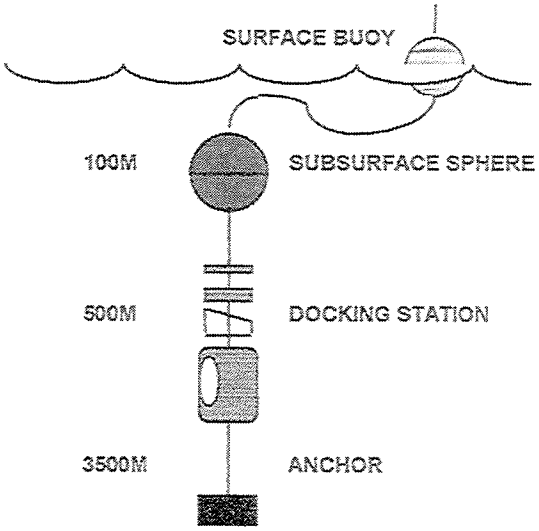
1.0 Introduction

The AOSN Deep AUV Docking Station was designed and built for MIT Sea Grant by the Deep Submergence Laboratory and the Applied Engineering Laboratory of WHOI and Electronic Design Consultants of North Carolina. The Station was fabricated in the summer of 1997, bench tested, wet tested, deployed to a depth of 500 meters in October 1997 during a test cruise to Site D off the New Jersey coast, revised at WHOI, and retested in preparation for an extended deployment. The Station was sealed and powered up again on 17 January for the (now-completed) 1998 AOSN cruise to the Labrador Sea on the R/V KNORR.

The Docking Station has not experienced a crippling failure since 17 January and has not been powered down since that date. The station was deployed a second time to a depth of 500 meters on 28 January for 14 days in the Labrador Sea and recovered successfully. A minimum of 30 days of on-board battery power has been consumed at the writing of this report.

2.0 Mooring Background

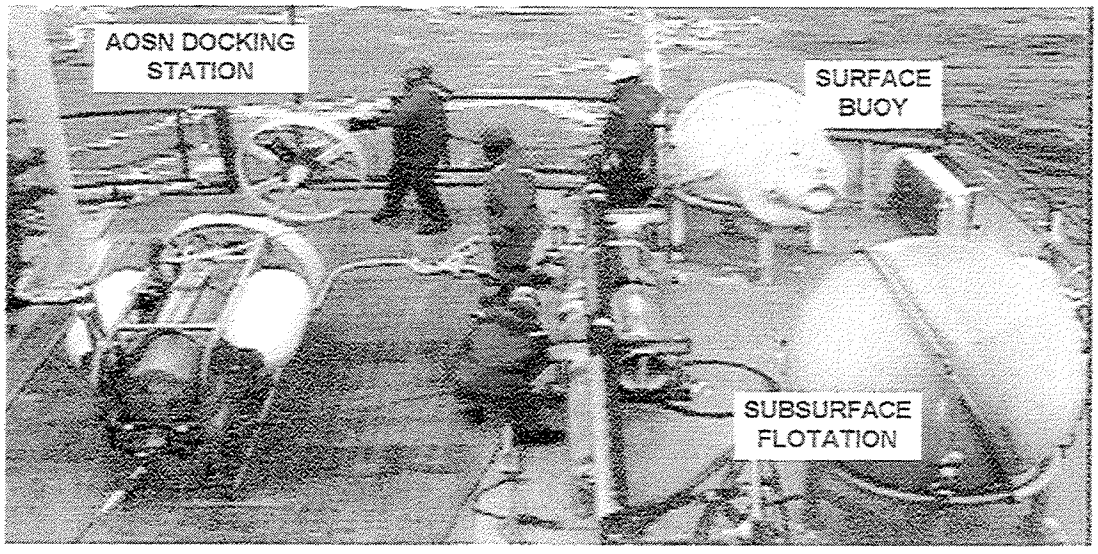
Three major mooring components appear in Figure [1]. The detailed design appears in Figure [24].



Except for the Docking Station itself, the remainder of the components and hardware making up the Labrador Sea AOSN Mooring have recognized histories of reliability and field longevity. The use of heavy duty strain reliefs, proven electro-mechanical terminations, a compliant s-tether configuration, pull-tested wire rope, new hardware and accurate ballast and buoyancy programs allowed mooring designers at WHOI to provide AOSN with a deep-sea system that was virtually trouble-free on two deep deployment opportunities, one in October 1997 and again this year in the Labrador Sea.

Data to and from the mooring, transmitted via satellite communications, are processed by electronics housed in the surface expression. Data transfer between the surface expression and the Docking Station occurs by a hardwired RS485 link. Data transfer between Station and AUV is accomplished by inductive link and acoustics.

Figure [1] AOSN Mooring Components on the Fantail of R/V KNORR



3.0 The Docking Station

A block diagram of the AOSN Labrador Sea Mooring and integral Docking Station appears in Figure [2]. The Docking Station is a tension-bearing device that provides services for an Odyssey class autonomous vehicle between data gathering missions. The Station is also capable of gathering data independent of the vehicle. It can withstand a five-knot mooring deployment transient and static tension through the frame of 3,000 lbs. Its mechanical components consist of a one-atmosphere aluminum frame, two battery housings, a dock controller housing, a docking pole, a moving carriage and motor, external sensors including magnetic switches, collapsible flotation, and wet harnessing. The Station components are pressure tested to 2,000 psig and the complete system is rated to a safe working depth of 1,000 meters. It weighs 2,512 lbs. in air and 930 lbs. at working depth. It is neutrally buoyant at the surface. For testing purposes, the Station can be deployed in water as shallow as 33 meters. A picture of the Station taken during mobilization and being lifted by its side bail appears in Figure [3].

Figure [2] Mooring and Docking Station, Block Diagram

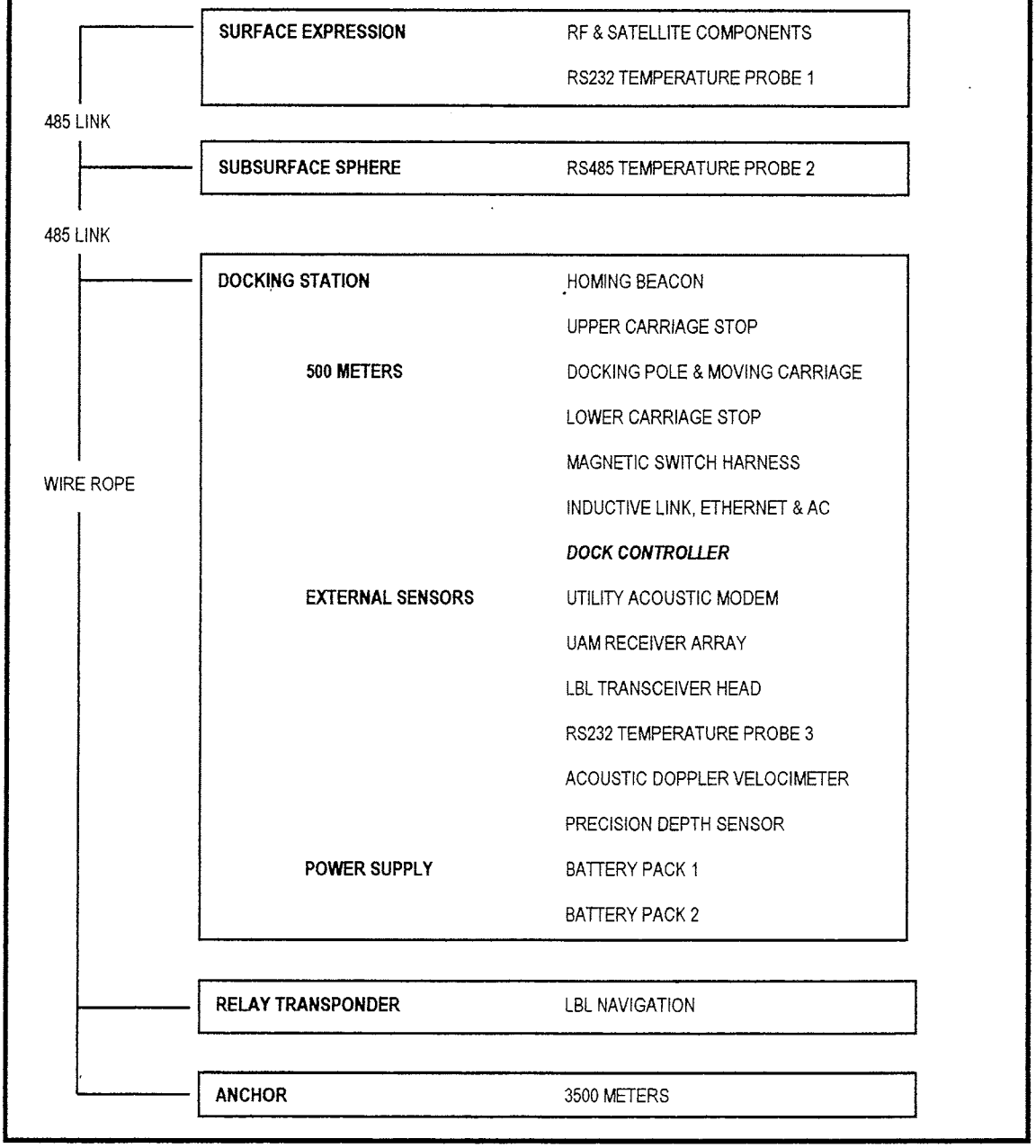
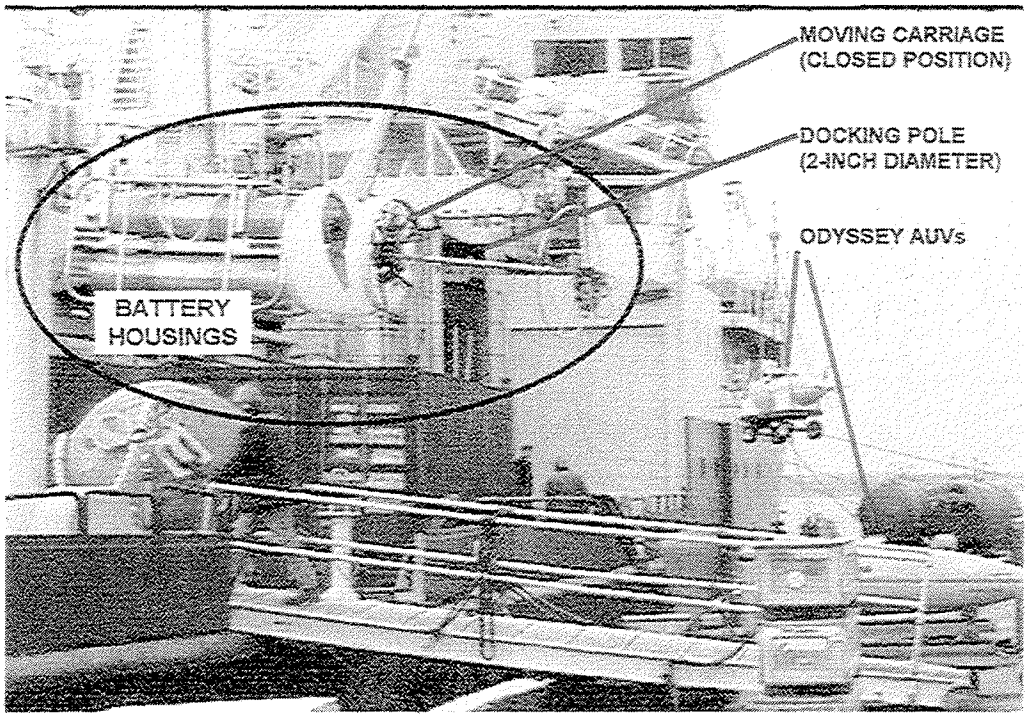


Figure [3] Docking Station (circled) and 2 AUVs



3.1 Docking Station Controller

3.1.1 Housing

The Docking Station Controller (Doccon) is a pressure-proof, cylindrical housing rated to 2,000 psig. The material used for the two endcaps and housing tube is a 6061-T6 aluminum alloy. Other materials used in the construction of the Doccon include Delrin, 300 series stainless steel, and various forms of poly plastics. The aluminum is cathodically protected from corrosion by strategically placed zinc anodes. The housing is nine inches in outside diameter (ten inches with hardware) and fifty-two inches long. It weighs 95 lbs. in air. When sealed, a minimum of ten, ten-gram desiccant packets are added to the volume to ensure humidity control.

3.1.2 Chassis Layout

The Doccon chassis layout appears in Figure [4]. The chassis framework is made up of adjustable aluminum shelves mounted at four corners to perforated aluminum channel. The channel is secured to one endcap only, allowing easy removal of the entire chassis and associated feedthroughs from the housing tube. The chassis is 7.5 inches in diameter. All power conductors are twisted pairs. High voltage circuitry is shielded and/or drained. Craftsmanship in construction meets and exceeds the best commercial practices.

Figure [4] Doccon Chassis, Mechanical Layout