

AGREEMENT

This Agreement is made as of February 11, 2002 by and between Monterey Bay Aquarium Research Institute ("MBARI") and Brooke Ocean Technology, Ltd. ("BOT") with reference to the following recitals:

WHEREAS, MBARI is developing an autonomous underwater vehicle (the "AUV") for use in underwater research in the oceans;

WHEREAS, BOT has submitted to MBARI a quote dated January 18, 2002 (the "Quote") to design and build a launch and recovery system (the "LARS") for use with the AUV and MBARI's research vessel, the R/V Zephyr;

WHEREAS, a copy of the Quote is attached hereto as Exhibit "A"; and

WHEREAS, the parties have agreed that BOT will design and build the LARS in accordance with the terms of the Quote and this Agreement.

In consideration of the mutual promises contained herein, the parties agree, as follows:

1. **Agreement.** BOT agrees to design and build the LARS in accordance with the terms of the Quote and this Agreement.
2. **Termination.** MBARI may terminate this Agreement at any time for any reason by giving BOT two weeks' prior written notice. In such event, MBARI shall pay BOT for the reasonable value of the work performed to the date of termination, taking into account any payments already made to BOT, and BOT shall deliver all work performed to the date of termination to MBARI at MBARI's expense. BOT shall also deliver the complete set of prints for the LARS, *as they exist at the time of termination*, to MBARI. BOT agrees that MBARI may use these prints to have the LARS completed and maintained, but MBARI agrees not to disclose them to any party for any other purpose.
3. **Design Warranty.** BOT hereby warrants the LARS against defects in design for the warranty period set forth in the Quote.
4. **J-Frame.** BOT agrees that the substitution of a J-frame for the A-frame design for the LARS will not alter the work schedule set forth in the Quote.
5. **Vessel and AUV Specifications.** *MBARI agrees to provide BOT with the specifications for the host vessel and AUV as soon as possible following contract award. BOT in turn will provide the deck footprint, deck reactions and LARS weight to MBARI in a timely manner.*
6. **Conflict.** The terms of this Agreement shall prevail in the event of any conflict with the terms of the Quote.
7. **Notices.** Any notice given under this Agreement shall be effective when sent by mail, facsimile or express delivery to the following addresses:

To MBARI: Monterey Bay Aquarium Research Institute
7700 Sandholdt Road
Moss Landing, California 95039-0628
Attn.: Michael Pinto, Chief Financial Officer
Fax: (831) 775-1620

To BOT: Brooke Ocean Technology, Ltd.
50 Thornhill Dr., Unit 11
Dartmouth, Nova Scotia
Canada B3B 1S1
Attn.: Geoff Lebans, co-owner
Fax: (902) 468-1388

8. **Dispute Resolution.** The parties agree to attempt in good faith to resolve any dispute relating to this agreement. If they are unable to do so, they agree to endeavor first to settle the dispute by mediation administered by the American Arbitration Association ("AAA") under its Commercial Mediation Rules before resorting to arbitration. Any unresolved controversy or claim relating to this agreement or its breach or any question of arbitrability shall be settled by binding arbitration administered by the AAA under its Commercial Arbitration Rules, and judgment on the award rendered by the arbitrator(s) may be entered in any court having jurisdiction. Any such mediation or arbitration shall be held in Monterey, California, unless another location is mutually agreed upon.
9. **Miscellaneous.** This is the entire agreement between the parties on the subject matter and may not be modified except in writing signed by both parties. This agreement shall apply to and be binding upon the heirs, personal representatives, successors and assigns of the parties. The rights and obligations of the parties shall be governed by and construed in accordance with the laws of the State of California. If any provision of this agreement is deemed illegal or unenforceable, the remaining provisions shall remain in full force and effect. Neither party shall assign this agreement or any obligations thereunder without the express written consent of the other. In any action to enforce or interpret this agreement, the prevailing party will be entitled to recover its reasonable attorneys' fees from the other party.

**MONTEREY BAY AQUARIUM
RESEARCH INSTITUTE**


Michael Pinto, Chief Financial Officer

**BROOKE OCEAN TECHNOLOGY,
LTD.**

Name: 
Geoff Lebans, co-owner



50 Thornhill Drive, Unit 11
Dartmouth, Nova Scotia
Canada B3B 1S1
Tel: (902) 468-2928 Fax: (902) 468-1388 E-mail: sales@brooke-ocean.com

Mailing Address:
P.O. Box 2220, East
Dartmouth, Nova Scotia
Canada B2W 3Y2

AUV LARS FOR RESEARCH VESSEL ZEPHYR

Quotation # Q02-002

January 18, 2002

1.0 BACKGROUND

The proposed LARS incorporates a basic concept used for the handling of bodies at sea; that is, *the motion of the payload is brought into phase with that of the ship during transfer to and from the air-sea interface*. The LARS will be designed in accordance with Lloyd's Code for Lifting Appliances in a Marine Environment.

This system incorporates a compliant capture saddle suspended from a double articulated A-frame capable of rotating through 140°. The saddle will maintain the AUV at or near horizontal at all times during the deployment and recovery process. The LARS will be powered using the existing hydraulic system and air compressor aboard the *Zephyr*.

The method of recovery involves securing a tow line to the AUV, winching the vehicle into the compliant capture mechanism, and transferring the AUV. The tow line is attached using a method that does not require a person in the water and can be attached to an AUV that is either underway or dead in the water.

2.0 SYSTEM ARCHITECTURE

The LARS will be designed in accordance with *Lloyd's Code for Lifting Appliances in a Marine Environment*. Design factors will meet Lloyd's requirements, including a duty factor of 1.2, hoisting factor of 1.9, and the appropriate stress factor. The lifting straps will have a minimum factor of safety of 8:1. All steel surfaces will be sand blasted to a near white finish, primed with zinc enriched primer, and finished with an epoxy top coat. The color is to be specified by MBARI. All welding will be undertaken in accordance with Canadian Welding Bureau, Lloyd's or DNV standards.

The LARS will be capable of deploying and recovering the AUV in up to sea state 4 conditions from the stern of the *Zephyr* or other suitable vessels of opportunity. The operating temperature range will be 0°C to +40°C. All hardware will be designed to survive operation in a harsh marine environment, including salt and freezing spray.

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The baseline LARS will be designed to handle an AUV which has a dry weight of 2,000 lb, is 16 ft long and 23 inches diameter. As described in Section 2.2, provision will be made to accommodate an increase in length up to 20 ft.

The LARS incorporates a hybrid A-frame and a compliant capture mechanism with integral docking saddle. The cage is free to pivot in the fore/aft direction with a caliper brake to provide damping. If necessary, the towline can be put under tension during deployment and recovery to further damp fore/aft pendulum motion. It is BOT's opinion that this method is sufficient to safely control the payload in sea state 4.

The recovery procedure following attachment of the towline is shown in Figures 1-5.

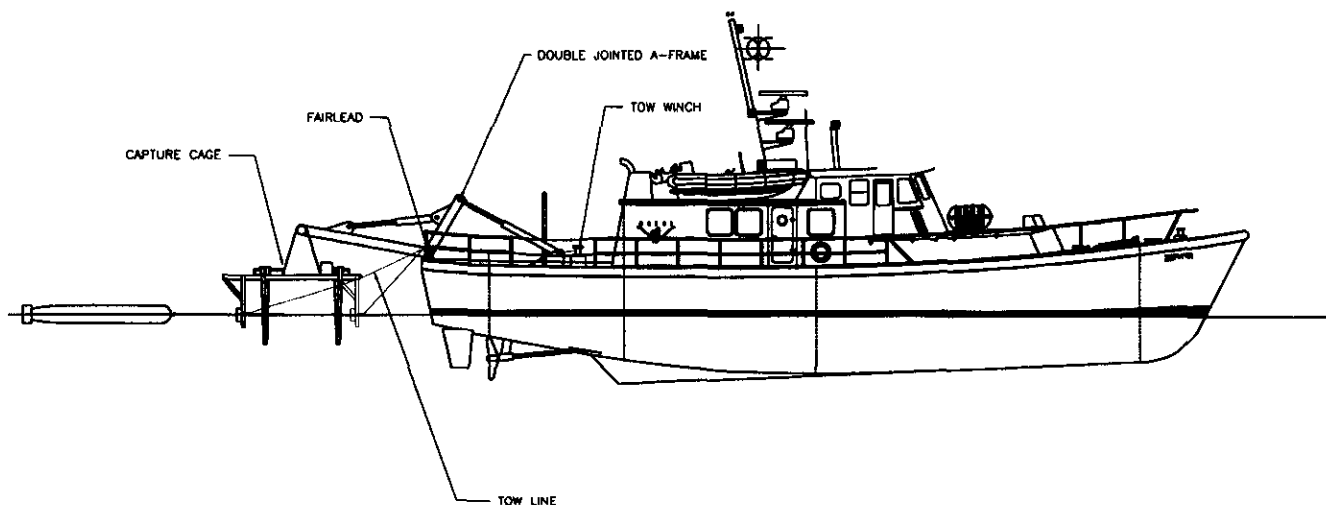


Figure 1 – AUV Under Tow

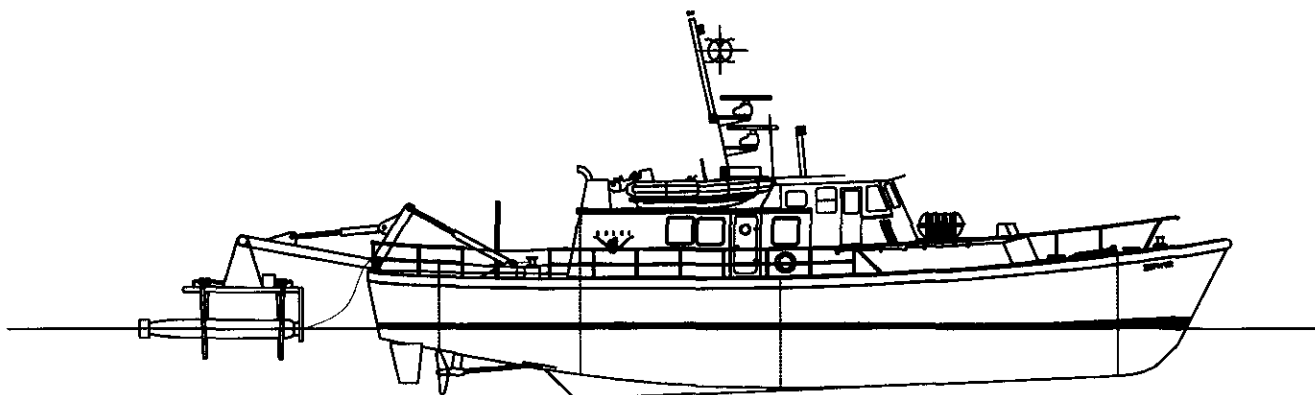


Figure 2 – AUV Docked

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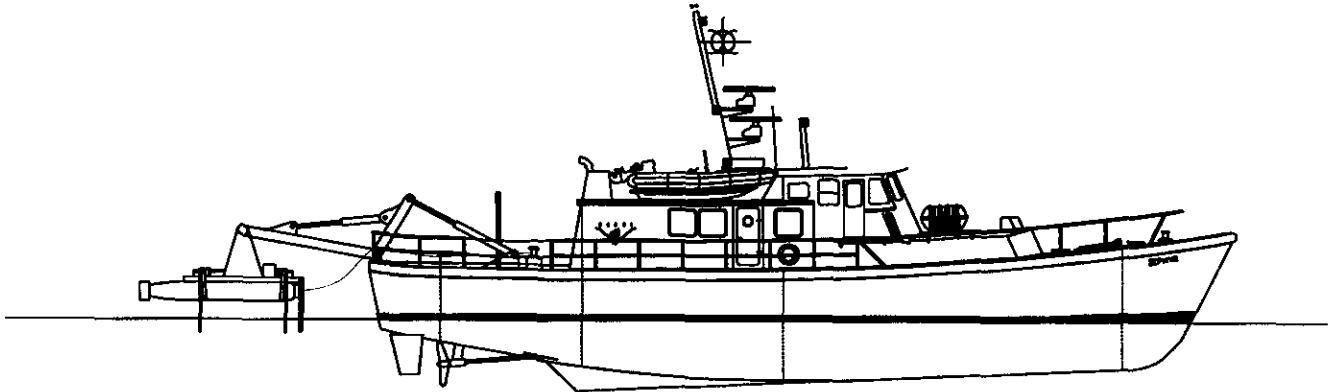


Figure 3 – Straps Retracted; AUV Secure

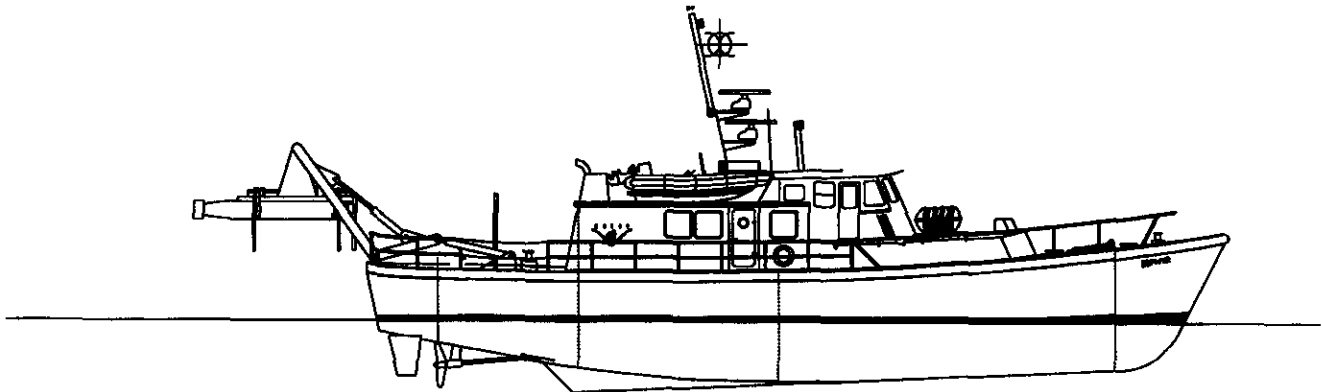


Figure 4 – A-Frame Transferred to Deck

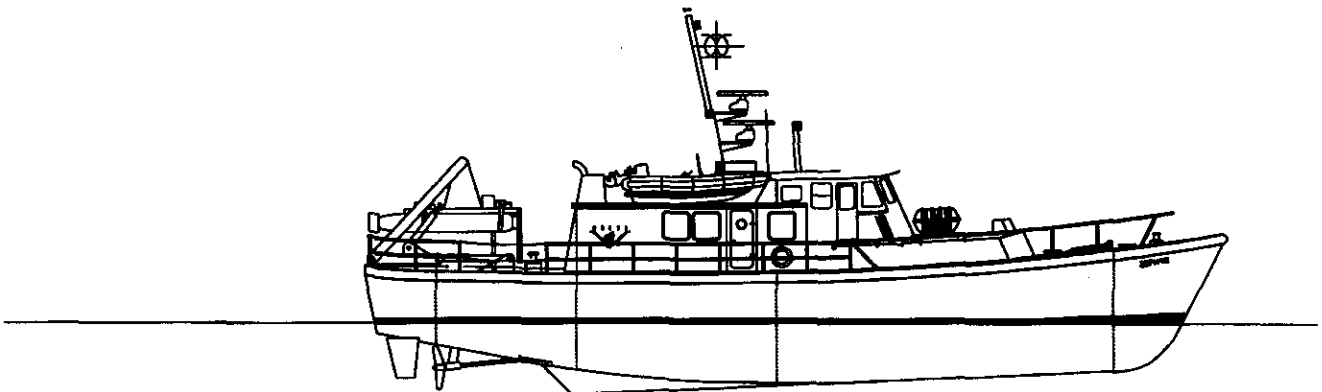


Figure 5 – AUV on Deck

The LARS is described in detail in the following sections.

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2.1 A-Frame

The A-frame is a double articulated device capable of rotating through approximately 140°. It consists of an inboard and outboard section, each actuated with twin hydraulic cylinders. The outer section is equipped with a crossbar which acts as the interface to the capture mechanism. Structural steel will be 50W (minimum yield strength of 50,000 psi). All pins will be stainless steel.

The base of the A-frame will consist of two rectangular weldments with reinforced pin joints. Pins will be equipped with lubrication points. The hydraulic cylinders will be marine grade.

The hydraulic system will incorporate dual counterbalance valves at each cylinder with built in reliefs to provide positive control at all times.

The A-frame provides 15 ft of outboard reach and 11 ft of inboard reach. It will be operated directly from the proportional hydraulic valve. Hydraulic power will be supplied from the ship's 15 gpm/3,000 psi hydraulic power supply.

Note: BOT will conduct a feasibility study to determine if the A-frame can be replaced by a comparable J-frame. The results of the study will be reviewed with MBARI and a decision made as to which overboarding structure will be constructed.

The price of the LARS will not change if the A-frame is replaced with a J-frame.

2.2 Capture Saddle

The capture saddle is comprised of a fore/aft backbone with two large loops formed with an air or water filled hydraulic hose under approximately 100 psi pressure. These loops provide a large relatively rigid entrance for the AUV. A docking mechanism, which is free to travel both horizontally on the fore/aft backbone and vertically on its own frame, is used to secure the nose of the AUV to the saddle.

Attached to each hose is a nylon lifting strap. Both straps are coupled to a drum keyed to a drive shaft on the frame. The driveshaft has a flange at mid-length for the addition of a third lifting strap for longer AUVs (see description below). Once the AUV is winched into the saddle and the nose is docked, the straps are wound onto the drums. Once winding commences, the straps automatically break away from the hose loops. The straps are retracted until the AUV is snug against the frame. The drums are powered directly from the ship's 3,000 psi hydraulic supply.

The saddle is connected to the A-frame with dual pin joints which restrict athwartships motion of the payload but allow it to pivot in the fore-aft direction. This permits the AUV to remain near horizontal in the saddle as the AUV is transferred between its deck cradle and the water. A hydraulic caliper brake system mounted at the pivot point provides damping. If necessary, the tow line could be used as a tagline to further stabilize the payload. As the brake cannot be powered directly from the 3,000 psi ship's supply, an accumulator with a charging circuit will be used to power the brake.

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Details have yet to be worked out but it is envisioned the hoses will be de-pressurized after the straps are retracted to allow them to collapse when the AUV is on deck

The forward end of the saddle is equipped with a tow line fairlead which, with the stern mounted fairlead, allows the tow line to be reeved from the towing winch through the capture mechanism to the AUV.

The docking mechanism is free to move vertically over a total range of about 6 ft to compensate for the relative motion between the AUV and capture mechanism in higher sea states. During recovery, the AUV is winched into the docking mechanism where the nose/towing hook of the AUV automatically locks in place using a spring loaded latch. Once locked in place, the AUV and docking mechanism are winched forward until the docking mechanism locks in place at the forward end of the capture mechanism.

To launch, the AUV is positioned just above the waterline and lowered by paying out the straps. The docking mechanism is then unlocked from the forward end of the capture mechanism and tow line paid out until the docking mechanism reaches a stop at the aft end. The AUV is then released from the docking mechanism latch and the latch that locks the docking mechanism to the forward end of the capture mechanism.

Both locking mechanisms are released using air powered cylinders.

The capture mechanism can be modified to permit the launch and recovery of an extended 20 ft AUV. This will be accomplished with the addition of a 3rd lifting strap and 2 ft extensions which will bolt on to each end of the capture mechanism. The lifting strap assembly is bolted to the drive shaft as described above.

An illustration of the capture mechanism is shown in Figure 6.

2.3 Control Station

The LARS will be operated directly from the hydraulic control valve using lever control. The valve will be integrated into a simple control station located near the stern. The control station will also have controls for the air powered functions (docking mechanism latch release and docking mechanism horizontal traveller release).

2.4 Towing Winch

The AUV is towed from a manually operated capstan (with hand crank) because tow loads are low and the operator can provide compensation; i.e., the ability to take up slack if the AUV surges ahead and pay out cable if a surge load is encountered. The capstan will be mounted on a bracket equipped with bolt on weld plates and will be located just forward of the A-frame as shown in Figure 1.

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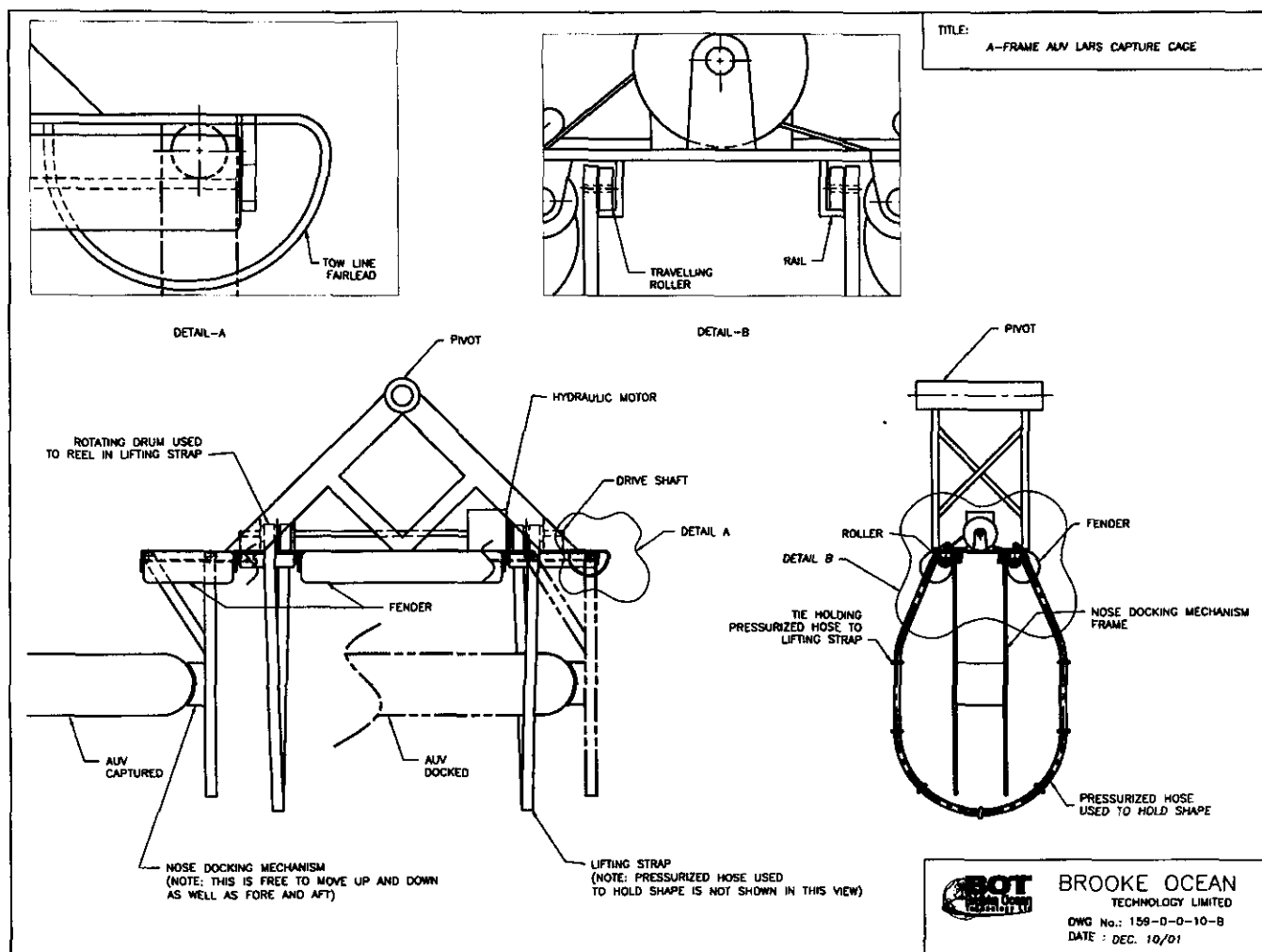


Figure 6 – Capture Mechanism Layout

2.5 Line Attachment System

This method utilizes a boom or crane (supplied by MBARI) to suspend a loop of tow line away from the side of the vessel, thus forming a U-shaped target (the other end of the tow line is reeved through the capture saddle to the manually operated towing winch). To attach the tow line, the *Zephyr* will approach the AUV from astern. Once the U-shaped target passes the AUV's thruster, it is lowered until in contact with the AUV's hull. The target line then slides along the hull until it is captured by a gated tow hook on the AUV. The tow line then automatically breaks away from the boom. The AUV will move aft relative to the *Zephyr* until the tow hook meets a fitting/stop integral to the tow line. The AUV is now under tow and can be pulled into the capture mechanism.

Figures 7 and 8 illustrates the tow line attachment procedure. Please note this drawing shows a crane rather than the A-frame.

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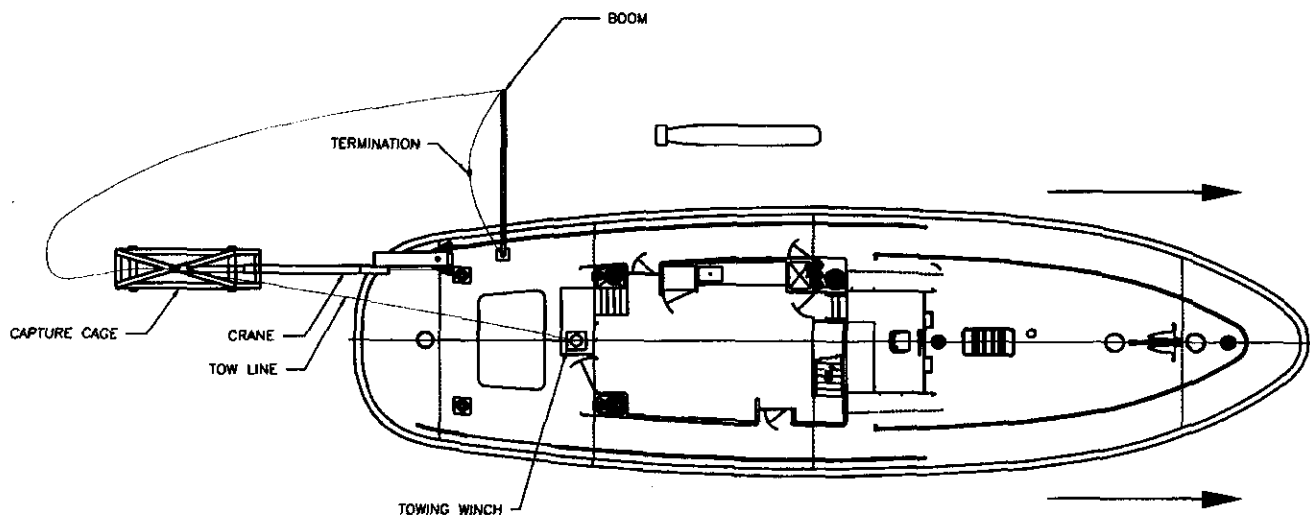


Figure 7 – Ship Approaches AUV with Tow Line Deployed

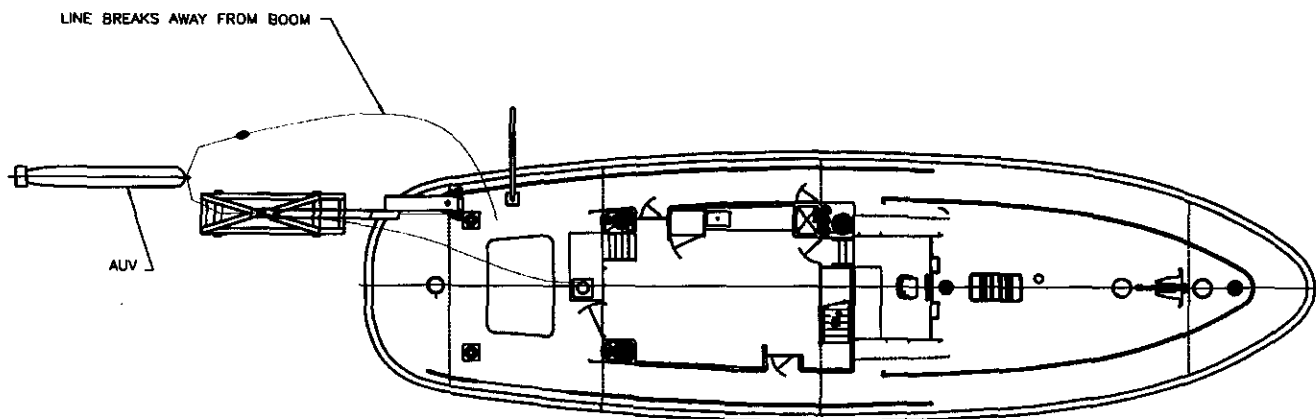


Figure 8 – Tow Fitting Approaching Tow Hook

Figure 9 shows the final step of engaging the tow fitting with the tow hook. The tow hook will be different in design than that shown here and will more closely resemble the hook shown in Figure 10. A passive retraction system developed for another Bluefin AUV is also shown here.

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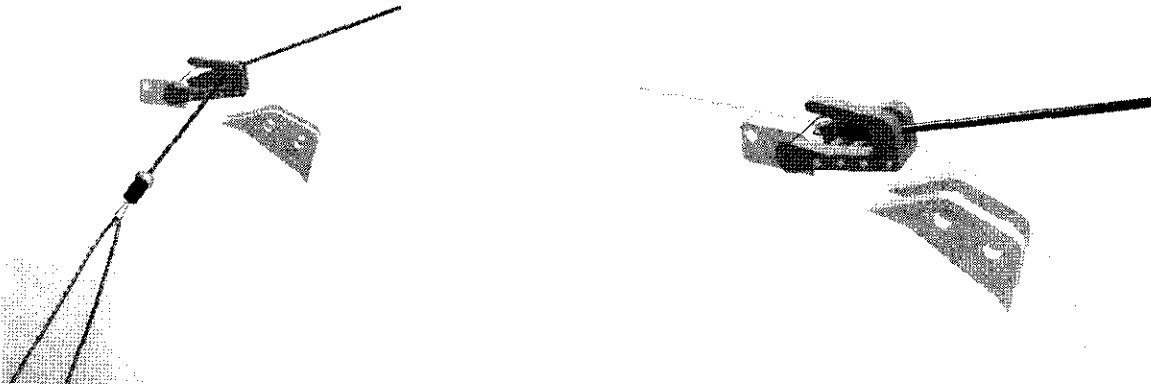


Figure 9 – Tow Fitting Engaged with Tow Hook

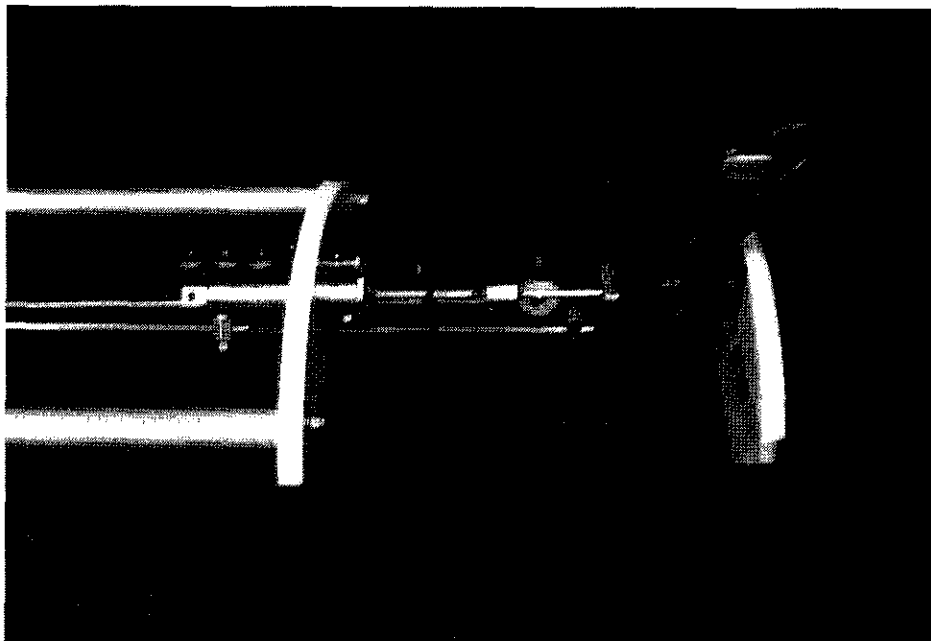


Figure 10 – Photo of Similar Tow Hook

2.6 Fairlead

A small tow line fairlead will be supplied for mounting at the stern. It will be equipped with bolt on weld plates for welding to the deck.

2.7 Documentation

The LARS will be provided with an operating and maintenance manual. The manual includes specifications, operating instructions, and preventive and corrective maintenance. The manuals will also include all of the OEM (original equipment manufacturer) documentation.

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2.8 Deliverables

Deliverables will include the following:

- i) AUV LARS as described this document
- iii) Documentation as outlined in Section 2.7
- iv) CAD drawing package, including:
 - system assembly drawings with complete bills of material and parts lists for items not covered by OEM reference
 - drawings for vessel and installation interface

An AUV deck cradle is also required – this will be supplied by MBARI with design input from BOT.

3.0 KEY PERSONNEL

Steve DeBelie, P.Eng.	Project Manager
Geoff Lebans, P.Eng.	Technical Consultant
Jean-Guy Dessureault, P.Eng.	Hydraulic System, Capture Mechanism
Paul Bezanson, P.Eng.	A-Frame/J-Frame, Structural Analysis

4.0 TESTING AND DELIVERY

Once the LARS has been assembled, factory testing will commence. This will consist of load testing and a series of functional tests to verify system performance. Initial functional testing will be completed at BOT's facility and will utilize the existing Bluefin AUV mockup to verify the fit of the AUV in the capture saddle. Load testing will be completed with the LARS mounted on a test jig at either the Winlie Group or Hawboldt Industries.

Load testing will include:

- LARS static load test to 2.0 x Safe Working Load (SWL) at outboard position
- LARS dynamic load test 1.5 x SWL over complete range of motion
- Repeat functional tests after load tests.

Test procedures shall be submitted to MBARI for review 30 days prior to the start of testing. MBARI shall be given 10 days notice prior to the start of testing to allow the attendance of a representative if desired.

5.0 QUALITY PLAN

5.1 Standard of Quality

BOT's quality assurance procedures will be in effect during this project. These procedures are in compliance with ISO 9001.

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5.2 Processes

Quality will be monitored/maintained through systematic design reviews, inspection of components, materiel tracking, and comprehensive testing.

6.0 FINANCIAL

The contract total is \$429,908 CDN as detailed below:

Budgetary price submitted Nov. 14/01.....\$413,820

LESS:

Hydraulic power unit.....(\$15,000)

Towing boom.....(\$5,000)

Portable control console.....(\$10,000)

OPTIONS:

Upgrade kit to extend the capture
saddle by 4 ft & add a third strap.....\$12,500

Hydraulic caliper brake assembly
and misc. hydraulic components.....\$8,000

Track system and locking device
for nose docking mechanism.....\$12,500

Towing hook passive retraction system.....\$10,294

Engineering assessment of J-frame.....\$2,794

TOTAL PRICE.....\$429,908CDN

Prices are in Canadian Dollars

Freight costs not included

Delivery: ready to ship 6.5 months from date of order

Proposed Payment Terms:

BOT will be paid the following amounts when the milestones below are reached:

Contract Award	20%	\$85,982	down payment; advance for design work
45 DAC (estimated)	10%	\$42,990	preliminary design complete
90 DAC (estimated)	10%	\$42,990	detailed design complete
120 DAC	20%	\$85,982	A-frame & capture mechanism hardware

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(estimated)			delivered
198 DAC	20%	\$85,982	factory testing complete; system shipped
230 DAC	20%	\$85,982	sea acceptance trials complete
(estimated)			

Should the sea acceptance trials be delayed, it is agreed that the final payment will be made no later than 3 months after the system is shipped from BOT's facility.

All prices are in Canadian dollars. Delivery terms are FCA Halifax, NS.

The AUV LARS is covered by BOT's standard warranty for a period of 12 months from the first use of the equipment by the end customer. Total warranty period is not in any case to exceed 18 months from the date of shipping. A copy of BOT's standard warranty is as follows:

WARRANTY

The LARS is warranted against failure due to defects in material or workmanship for a period of 12 months from the first use of the equipment and no longer than 18 months after shipping. BOT will repair or replace, at its option, any defective components at no charge.

This warranty does not apply if failure or damage has been caused by accident, misuse, abuse, lack of maintenance, or unauthorized repairs/modifications.

BOT is not liable for consequential damages and this warranty is limited to repair or replacement of the product.

Manufactured items integrated into the LARS are covered by their respective warranties.

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* * * COMMUNICATION RESULT REPORT (FEB. 19. 2002 9:13AM) * * *

FAX HEADER: MBARI

TRANSMITTED/STORED : FEB. 19. 2002 9:12AM
FILE MODE OPTION

ADDRESS

RESULT

PAGE

028 MEMORY TX

819024681388

OK

1/1

REASON FOR ERROR
E-1) HANG UP OR LINE FAIL
E-3) NO ANSWERE-2) BUSY
E-4) NO FACSIMILE CONNECTIONMONTEREY
BAY
AQUARIUM
RESEARCH
INSTITUTE

M B A R I

**COPY****PURCHASE ORDER**

Purchase Order Invalid Without PO#

PO#1 PO-0200396

DATE: 2/13/02

VENDOR: Brook Ocean Technology Ltd.

ADDRESS: PO Box 2220

East Dartmouth, Nova Scotia

Canada B2W3Y2

Phone: (902) 468-2928

Fax: (902) 468-1388

Contact: Geoff Lebans

SHIP TO:

☐ 7700 Sandholdt Road

Moss Landing, CA 95039-9644

☐

SHIP VIA:

☐ UPS☐ FedEx☒ Truck

EXPECTED DELIVERY DATE:

FOB: ☒ Shipping Point ☐ Destination

PAYMENT TERMS: as outlined in quote

Send Invoices to:

MBARI Accounts Payable

7700 Sandholdt Rd., Moss Landing, CA 95039-9644

Phone: (831) 775-1700 Fax: (831) 775-1630

REQUISITIONER: Steve Etchemendy

ITEM	QTY.	U/M	PART NUMBER	DESCRIPTION	UNIT PRICE	EXTENDED
1	1			Launch and Recovery system for MBARI	\$270,842.00	270,842.00
				Research Vessel Zephyr (AUV)		-
				In accordance with BOT quote #Q02-002		-
				dtd Jan. 18th, 2002 Total price \$429908 CND		-
				FOB Halifax Canada.		-
				\$429,908 CND as of 12/2/02 = US \$270,842		-
				This purchase is in Canadian dollars! Unit		-
				price in US dollars is an estimate.		-
				Reference contract BOT/MBARI dtd 2/12/02		-
						-
				20% contract award		-
				10% 45 days after contract DAC		-
				10% 90 DAC		-
				20% 120 DAC		-
				20% 198 DAC: 20% acceptance trials		-

PROJECT/ACCOUNT CHARGE NUMBER: 900201.01 1500-560

AUV Launcher

SUBTOTAL 270,842.00

SALE/USE TAX 7.25% 19,636.05

SHIPPING

TOTAL \$ 290,478.05

REMARKS:

APPROVAL:

DATE:

MBARI is an Affirmative Action/Equal Employment Opportunity employer. MBARI does not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. MBARI takes affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. MBARI will comply with the provisions of Executive Order 11246 of 9/24/65, and relevant rules and regulations as required by law. Please be advised that all contractors and subcontractors having 50 or more employees and a federal government contract or subcontract of \$50,000 or more must develop a written affirmative action plan under the federal guidelines.

Form Revised 04/13/01