ODIM Brooke Ocean
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

Proposal for an AUV Launch and Recovery System
Q07-261

Prepared for:
Monterey Bay Aquarium Research Institute
Attention: Hans Thomas

Prepared By: ODIM Brooke Ocean
50 Thornhill Drive, Unit 11
Dartmouth NS
B3B 1S1
Tel: (902) 468-1860
Fax: (902) 468-1388

Contact: Steve De Belie, P.Eng.

September 14, 2007

1 Introduction

Monterey Bay Aquarium Research Institute has asked ODIM Brooke Ocean to provide a launch and recovery system (LARS) for their 21 inch AUVs. This system is loosely based on the AUV LARS delivered by ODIM Brooke Ocean to Thales, and recently used by MBARI. The proposed system consists of:

- Hiab 201-2 marine crane with integral winch
- Remote and local control for the crane and winch
- Capture head with integral cable sheave, load latch and capture saddle
- Electro-hydraulic power unit
- Crane base for ship installation
- ISO container for storage and shipping

Figure 1 – AUV LARS delivered to Thales in 2001

MBARI provided a system specification (see Appendix 1) and additional email outlining changes to the spec (also found in Appendix 1). Subsequent conversations with Hans Thomas also contributed to the system offered below.

2 Crane

Based on preliminary investigation and discussion with Hans Thomas at MBARI, the crane used will be a Hiab 201-2 Marine crane with 2 extensions. This is the newest version of Hiab marine crane. The crane will have a hydraulic winch rated for 2,041 kg (4,500 lbs) mounted on the secondary boom. A portable wireless remote operator control will be provided in addition to the standard crane mounted controls (see Section 5).

A Palfinger 18500 crane was also considered. It has similar lifting capacity (maximum lifting moment of 132,761 ft-lbs vs 136,448 ft-lb for the Hiab), however the slewing torque capacity is not as capable as that offered by Hiab (16,964 ft-lbs, vs 31,420 ft-lbs).

The Hiab crane is rated for lifting 2,160 kg at 8.3m reach, which exceed's MBARI's requirement of minimum reach of 7.8m. The requirement for a minimum safe dynamic working load of 1,780 kg at full reach (plus the capture head and winch weights) may require this spec to be reduced a small amount to avoid having to spec a larger, heavier and more expensive crane. Detailed analysis will be completed after contract award to determine the maximum allowable reach.

The Hiab crane has the following features:

- □ Stainless steel pipes, fittings and fasteners

- □ Shot blasting and 3-stage marine grade paint
- □ Extension booms hot dip galvanized
- □ Double chroming of all cylinders
- □ Heavy duty oil bath marine base and slewing system
- □ Zero leakage load holding valves on first and second lifting boom cylinders, extension cylinders and slewing cylinders
- □ 400˚ rack and pinion slewing system. Heavy duty oil bath lubrication
- □ 7˚ slope capability (full load capacity at 7˚ slope)
- □ Fitted with a Rotzler TH-2 Marine winch with 2041 kg (4,500 lb) capacity, mounted under the outer boom

Specifications for the HIAB 201-2 marine crane are included in Appendix II.

3 Capture Head

The capture head is attached to the Hiab crane, using a mounting sleeve that slides inside the outer boom extension, and secured with through-pins that allow quick installation and removal. The capture head will allow motion along the roll axis (when operating from the ship's side). This motion will be passively-damped using hydraulic or gas cylinders.

The capture head will also incorporate a latching system that will automatically latch into the lifting cable termination when hoisting. The load latch will allow the lifting cable to be slack while articulating the crane with the AUV latched. A hand-operated lanyard, led back to the crane base, will release the latch. As a safety measure, the operator will not be able to release the latch when the load is on it.

The capture head will have an integral sheave for the lifting cable and will be rated for the weight of the AUV (890 kg with entrained water).

The capture head will be fitted with a circular bumper, allowing the vehicle to be secured in any orientation.

The crane base will be fitted with a special cradle for the capture head, allowing quick and easy installation and removal from the crane.

4 Hydraulic Power Unit

The system will be supplied with a self contained hydraulic power unit (HPU) with the following features:

- □ 15 HP, 3 phase 460 VAC TEFC high efficiency electric motor with IP65 treatment
- □ Air/oil cooler with seawater resistant coating
- □ Level gauge, thermometer, breather and return filter
- □ NEMA-4X enclosure containing motor controller, on/off switch, main breaker
- □ Anti-condensate heater for electric motor
- □ Marine rated components
- □ Denso tape protection for plated steel fittings
- □ 24 in x 24 in 1" UNC bolt-hole mounting pattern

Figure 2 – Hydraulic power unit for Thales AUV LARS

5 Controls

The crane and winch manual controls will be located at a console on the crane base. Additionally a wireless Polar 5200M Marine 900Mhz radio Remote Control (supplied by Atlas Polar, the crane distributor) will allow the operator to position themselves for best visibility.

The HPU ON/OFF switch, emergency stop button and main breaker are located in a NEMA 4X enclosure mounted at the HPU.

6 Crane Base

The crane will be mounted on a specially designed crane base that will allow the system to be mounted to a UNOLS-type 24” x 24” bolt hole pattern. The base will be rated for the crane safe working load. The overall size of the base is expected to be 8 ft x 8 ft, however design analysis may determine that a larger, or smaller, base may be required. Should this be the case, the system price will be adjusted accordingly.

The base will be constructed from welded steel structural sections and painted using a marine coating system.

7 Cable and Termination

The crane winch will be fitted with a steel lifting cable (size, construction and length to be determined), and custom swivel termination, with integral interface for the load latch. A lifting hook, sized to mate with a hook on the AUV will be provided.

8 Shipping Container

The system will be shipped and stowed in a 20 ft x 8ft wide ISO container, with the top and long side sections removable as one piece. The container will hold the Hiab crane, capture head, hydraulic power unit, crane base and crane controls. Due to height limitations, and the possibility that the crane base may be larger than 8ft x 8 ft, the crane may be removed from the base, and the base stored in a vertical position so it will fit inside the container.

Note: Should the crane base be larger than 8 ft x 8 ft, it may be necessary to either a) make the base in pieces sized to fit inside the container, or b) consider an alternative means of storage for the crane base.

9 Quality Assurance

All operations at ODIM Brooke Ocean are monitored by Quality personnel, whose responsibility it is to ensure that controls are placed on planning, design, production, documentation, testing, and field support. ODIM Brooke Ocean 's existing Quality system is presently being configured to comply with the requirements of ISO 9001. These standards represent the most stringent control systems for design and manufacturing activities, and as such provide a high degree of Quality Assurance in all phases of operation within our facilities and in the field.

Although ODIM Brooke Ocean is presently not certified to ISO standards, our QA system has been audited by other prime contractors and can be audited by MBARI if required.

Where many systems will provide for Quality checks on outgoing products, the strategy employed at ODIM Brooke Ocean is one of "total Quality", in which Quality Assurance via walk-throughs, audits, design reviews, prototype tests, calculation verifications, and all of the supporting planning and administrative documentation at the "front end" are performed before manufacturing actually begins. Once the System Requirements Specification, System Design Documents, Detailed Design Documents (and supporting test, and user documentation) are approved, the production run is executed, along with the various in-process tests, inspections, and calibrations, which were previously identified during earlier high-level and detailed-level design phases. Because of the comprehensive specifications and system level design documents which are required by the Quality Program, final acceptance testing against the contract requirements and the System Requirements Specification ensures a trouble-free product.

9.1 Factory Acceptance Testing

BOT's Quality policy calls for all test requirements to be supported by detailed procedures. Since successful Factory Acceptance Testing confirms that the product meets specification and is able to be shipped, we welcome client input in this phase, and, as well, their attendance during these tests. Following completion of these tests, a Factory Acceptance Test Report will be submitted.

All testing is conducted according to procedures so that there is no confusion about *how* the test is to be conducted, and also so that it is clearly understood how the test results are to be interpreted. Therefore, all test parameters will be supported by procedures will clearly state how to conduct the test, and will also specify the required results with tolerances. Problems can result if tests are conducted only from a *plan*.

Once the LARS has been assembled, Factory Testing will commence. This will consist of proof testing and a series of functional tests to verify system performance. Initial functional testing will be completed at ODIM Brooke Ocean's facility. Load testing will be undertaken at CTS Containers. CTS will be fabricating the ISO container and are located close to ODIM Brooke Ocean.

9.2 Optional Commissioning/Operational Testing/Training

As an option and in addition to the proposed system price, ODIM Brooke Ocean proposes to provide 1 person to participate in Commissioning/operational testing for a period of 1 week. This testing will be conducted following delivery of the LARS to MBARI.

During the commissioning phase BOT staff can also provide training to MBARI. Training topics will include a comprehensive review of system operation, maintenance procedures, mobilization, and de-mobilization. Maintenance training will include the following:

- Theory of maintenance
- Preventive maintenance
- Corrective maintenance

Training will be conducted in a classroom and in a hands-on type setting on the vessel. The hands-on training could be completed concurrent with operational testing. Prior to the training session, BOT will submit a course outline to MBARI for approval.

Cost for this option is available upon request once the scope is agreed upon with MBARI.

10 Documentation

BOT will provide a commercial grade operations and maintenance manual that will contain system specifications, operation instructions, preventative maintenance schedules, troubleshooting tables, mechanical assembly drawings, electronic and hydraulic schematics and component data sheets.

11 Price

The proposed AUV LARS is priced at $402,103 CDN.

- □ FOB our facility in Dartmouth, Nova Scotia, Canada
- □ Applicable taxes, duties, fees and charges extra
- □ Shipping charges extra
- □ Quotation valid for 30 days
- □ Standard ODIM Brooke Ocean LARS 1 year warranty

Payment terms

Invoices will be issued at the following milestones:

- □ 20% On receipt of contract
- □ 20% on completion of design
- □ 30% on completion of assembly
- □ 15% on completion of Factory acceptance testing
- □ 15% on shipping of system

Payment due within 30 days of invoice issue.

Delivery is 24-26 weeks ARO. Note this is driven primarily by the delivery of the Hiab crane. Every effort will be made to improve on this delivery time if possible.

Appendix I

MBARI Ship of Opportunity AUV Launch and Recovery Specification

Summary

The Monterey Bay Aquarium Research Institute (MBARI) requires a portable launch and recovery system (LARS) for its AUV operations. The system will be temporarily installed on suitably sized oceanographic research vessels with freeboards ranging from 2 feet to 14 feet, and should be capable of recovering the vehicle in up to 25 knots of wind and 10-12 foot seas (sea state 5). The system will utilize a suitably sized articulated hydraulic crane as the main moving component. The crane will be equipped with a capture head which restrains the AUV in all degrees of freedom, as well as a latching mechanism which secures the lifting wire when the vehicle is lifted into the capture head. The system should be shippable in a standard height 20 ft ISO shipping container. In addition, the capture head shall be adaptable to existing articulated cranes should the host vessel be so equipped.

The selected vendor will be responsible for providing system components, documentation (including a detailed BOM for spare parts purposes), and training. The full system will go thru factory acceptance trials at the vendor's facility prior to shipping, followed by sea acceptance trials at MBARI using a suitable crane already mounted to an MBARI vessel.

AUV Specification

MBARI's AUVs are of robust construction, with an external plastic fairing and a single point lift point suitable for picking the AUV from the water. The single point lift is of all titanium construction, and features a snap gate entry, allowing a line to be led thru it. Hard points are fitted at the nose as well for securing controlling lines. The vehicles are cylindrical in shape, and range from 14 feet to 18 feet in length. The dry weight of the AUV varies from 350kg to 700kg, and the weight can reach 890kg with entrained water. Additional details are available upon request.

Figure 1 MBARI Mapping AUV, 17.5' Length, 21 in Diameter

System Description

The resulting LARS system shall be comprised of the following elements:

1. ISO compatible shipping container with removable top lid & suitable hard points for securing LARS components
2. Articulated crane with extension of 7.8m or greater
3. Shipboard crane foundation suitable for bolt-down to 24'' by 24'' bolt pattern, 1''/10 UNC fasteners. Minimum bolt depth into deck is .5''
4. Hydraulic Power Unit (HPU) suitable to operate crane, mounted to independent base suitable for bolt down to 24'' by 24'' bolt pattern, 1'' UNC bolts, with suitable hoses to interconnect to crane base
5. Unidirectional capture head with latching mechanism, pitch damping, and actuated slew axis.

MBARI has a large HPU in-house which may be suitable for this application, depending on crane model. If it is suitable, MBARI will furnish this HPU to the vendor, covering the necessary shipping costs to transport it to the vendor's site. The vendor will be responsible for providing all other system components.

It is not anticipated that the system will be operated in extreme latitude situations such as the Arctic or Antarctic.

Host Vessel Infrastructure

The host vessel will be capable of supplying 480V/3 phase power at appropriate amperage to the system. The mechanical interface between the ship and LARS will consist of a 24'' x 24'' OC bolt pattern of 1'' UNC fastners (standard UNOLS bolt pattern). Both the shipboard crane foundation and HPU must interface to this bolt pattern. Welded installations are not possible, as oceanographic vessels do not allow welding to deck. Deck loading should not exceed 1200 lb/sqft in compression, and mounting bolt tension should not exceed 5000 lb per bolt. Mounting bolt shear should not exceed 5000lb per bolt. The vessel in many cases features crane lifting capacity up to 14,000 lb; the heaviest component of the system should therefore not exceed this weight to allow loading without an additional crane.

Many potential vessels of opportunity feature an existing articulated crane, and the capture head shall be adaptable to these cranes when possible. This avoids the costs of shipping the entire crane, foundation, and other elements of the complete system. Many of these cranes are HIAB 200 series cranes, although other cranes are possible. This issue is discussed more fully in the section on the capture head.

Shipping/Storage Container

All LARS components, including spares, shall be transported in a 20ft ISO shipping container. The preferred configuration is a top-loading shipping container, with end-loading doors and a removable steel lid. This will provide a high level of protection to the equipment while in storage, and facilitate rapid and safe unloading of the heavy elements via overhead crane picks. Reference dimensions (based on ISO) for such a container are:

- Length –

    - Exterior: 19’10’’
    - Interior: 19’4’’
- Height –
    - Exterior: 8’6’’
    - Interior: 7’9’’
- Width –
    - Exterior: 8’0’’
    - Interior: 7’9’’
- Max Payload – 48150 lb

The container should have the following features:

- transport foundation for crane
- tie down points and bracing sufficient to secure the crane during shipping
- tie down or bolt down points for the deck foundation and HPU
- tie downs for bulk storage containers containing spare parts

Because of the weights of the various components, this might require a highly customized container to not exceed floor loading requirements. In addition, the interior load should be reasonably well balanced in the container, to allow handling of the container via a forklift.

Articulated Crane

The articulated crane is the prime moving element of the system. It must be capable of lifting the vehicle from the water at full extension with a safety factor of 2. This requires a minimum safe dynamic working load of 1780kg at full extension, not including the weight of the capture head. When folded into its stowed configuration and mounted to its transport base, it must fit within the height and width constraints of the shipping container. Reach of the crane should be a minimum of 7.8m, although increased reach is preferred since it allows operation further away from the side of the vessel, or from a higher freeboard. The crane shall include a belly pack style remote control for essential crane functions. Ideally, this shall be an off-the-shelf remote. Capture head functions do not necessarily need to be integrated into the remote control, but can be located at the crane base. Preferred crane type is HIAB model 200 C-2, since this simplifies interchangeability of the capture head with other MBARI cranes. Other types of crane under consideration at MBARI for this application are the Palfinger Modem 18500MB. The crane shall be of marine grade construction.

The vehicle is lifted using a shallow entry J-style hook, similar to that used in the BOT system built for Thales.

Shipboard Foundation

The crane will interface to the ship via a foundation which mounts to the 24’’ by 24’’ deck bolt pattern. This foundation will distribute the weight of the crane and the reaction forces from crane motion so as not to exceed the deck mechanical limits. The foundation structure will incorporate lift points allowing it to be easily handled via overhead crane

lifts, and will bolt down into the shipping container for ease of transport. The foundation shall be constructed of steel, blasted and painted for marine service.

Hydraulic Power Unit

The hydraulic power unit (HPU) shall operate from 480V/3 phase power supplied by the host ship. The unit shall meet the flow and pressure requirements recommended by the crane. The HPU shall be mounted to a base skid appropriate for bolt-down mounting the the ship's deck bolt pattern.

MBARI has a large HPU available for this project, and will work with the vendor to determine whether it is appropriate based on the crane selected. MBARI will furnish this HPU to the vendor if appropriate for integration and testing of the system.

Capture Head

The capture head consist of the following elements:

- flange-mounted adapter which interfaces the head to the outer boom section of the crane
- a passively damped pivot about the horizontal axis normal to the crane boom, allowing the load to hang vertically as the crane is articulated
- a sheave over which the lifting wire is led
- a latching mechanism which supports the load independent of wire tension
- a hydraulically actuated slew axis which can rotate the AUV in the horizontal plane, even with wire tension applied
- an unidirectional capture saddle which cushions the vehicle and restricts in motion

In order to keep the system as simple and minimize control functions at the head, the latch mechanism shall be operated via a small lanyard (rather than as an electro-hydraulic function). Once the lanyard is pulled, the latch is ready to release. Lifting vehicle weight off the latch mechanism should then cause it to release, so that wire can be fed out to launch the vehicle. When recovering the AUV, the latch mechanism should automatically latch the wire when it has been pulled in sufficiently. The slew axis shall be independent of the wire sheave, allowing wire tension to be applied regardless of vehicle orientation.

Since the head may be integrated onto existing shipboard cranes, it is important not to compromise basic crane functions. The capture head shall be designed to accommodate the safe working load of the crane at minimum extension (7000kg for a HIAB 200 series)

Launch Scenario

During launch, the capture head is positioned over the AUV lift point and wire is fed out. A launching line is led to the J-hook, allowing it to be pulled free once the AUV is in the water. The hook is inserted into the AUV's lift point, and the vehicle lifted until it is restrained against the saddle and the hook latches. Wire is then fed out to ensure that the latch is secure.

The crane operator then slews the crane and booms out until the boom is positioned perpendicular to the rail, with the vehicle above the seas. The unlatching lanyard can now be pulled. The crane operator whips up wire until the latch releases, then whips down to lower the vehicle into the water. Once the vehicle is in the water and the hook is unloaded, the launching line leading to the hook is pulled to free the hook from the AUV. The ship then maneuvers clear of the AUV

Recovery Scenario

Two operators are required for recovery, one to operate the crane, the other to handle clipping a line to the AUV lift point. The ship maneuvers alongside the AUV, with the AUV to weather. A messenger line, leading to the crane J-hook, is snapped thru the AUV's lift point using a long crescent shaped pole (the same pole used in our Zephyr recoveries). The vessel can then slowly fall off to leeward, while the messenger line is tended. The crane operator maneuvers the crane as necessary to position it over the AUV. The messenger line operator maintains tension on the messenger, which also guides the AUV to the lifting hook. The messenger operator can then apply tension to cause the J hook to engage into the lift point. The crane operator can then whip up wire to lift the AUV clear of the water, up into the capture head, where the wire is securely latched. The crane is then articulated, and vehicle slewed, to position the vehicle over its deck cradle. The second operator can then manually activate the latch, allowing the crane operator to whip up, unlatch, and lower the vehicle into place.

Steve DeBelie

From: Thomas, Hans [hthomas@mbari.org]
Sent: Saturday, August 25, 2007 4:24 AM
To: Steve DeBelie
Cc: Geoff Lebans; Derrick Peyton
Subject: RE: AUV LARS

Folks -
A couple of comments based on conversations this week with Brooke and others.

1)using a hicube shipping container is acceptable. I would still like to retain a hard-top design (rather than a canvas top), because the container & crane would be stored outside at our facility for long periods of time, and I want to minimize corrosion and sand damage while it is in storage

2)After some discussions on our end, we feel that the slew axis on the capture head could be eliminated, which would simplify the mechanical design of the head, and eliminate the need for additional hydraulic circuits to be run on the crane. We still want to retain a latching mechanism, which would be manually activated via a lanyard or other manual mechanism. Also, we would still need the damped pitch motion. Please respond as to whether or not this is reasonable.

2)From conversations at our end, it seems that HIAB is getting out of the marine crane business. We are having a hard time sourcing a marine crane from them for an ROV launch & recovery operation. Are you guys experiencing the same? We've been looking around at different options, and the palfinger 18500MB is looking better. If this crane would be acceptable, we have located one in Massachusettes which we can purchase and supply to you for this application. The vendor can also supply a mounting foundation which would fit the constraints of this project, HPU/soft start, valve pack, and wireless remote control. If we were to pursue this purchase, I would want to ammend the RFP to you, and have brooke supply the capture head w/ latch and an appropriate hi-cube van for transporting the crane & capture head. The crane & foundation would become MBARI furnished items which will be supplied to Brooke.

Regards

Hans Thomas
AUV Supervisor, Division of Marine Operations
Monterey Bay Aquarium Research Institute
831-775-1976 (landline)
831-869-5693 (mobile)

From: Steve DeBelie [mailto:sdebelie@brooke-ocean.com]
Sent: Mon 8/20/2007 10:20 AM
To: Thomas, Hans
Cc: Geoff Lebans; 'Derrick Peyton'
Subject: RE: AUV LARS

Hi Hans,

Thanks for this. When do require the proposal, and when would you require delivery of the system?

Appendix II

HIAB	SEA CRANE	Doc No.	DES - 403	
		Page	1 / 16	
		Date	2003. 12.	0

Hiab 201 **Technical data**

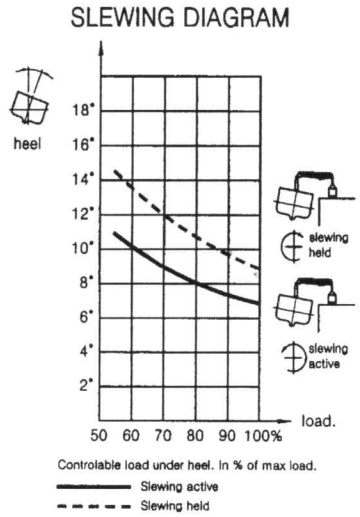
	201-1	201-2	201-3	201-4
Lifting capacity	190KNm	185KNm	176KNm	169KNm
Hydraulic outreach	6.38 m	8.33 m	10.30 m	12.28 m
Hydraulic boom outreach	1.82 m	3.64 m	5.46 m	7.28 m
Lifting height above installation level	9.2 m	11.1 m	13.0 m	15.0 m
Outreach - lifting capacity	2.0m/8,750kg	2.0m/8,700kg	2.0m/8,650kg	2.0m/8,400kg
	4.5m/4,250kg	4.7m/4,020kg	4.8m/3,720kg	5.0m/3,450kg
	6.3m/3,040kg	6.5m/2,820kg	6.6m/2,630kg	6.8m/2,460kg
		8.3m/2,160kg	8.4m/2,000kg	8.6m/1,890kg
			10.3m/1,620kg	10.4m/1,510kg
				12.2m/1,260kg
Recommended oil flow	40 l/min			
Power needed	16 kw			
Working pressure	24 Mpa			
Slewing angle	400 deg			
Maximum working slope	7 deg in full load capacity			
Slewing torque	42.6 KNm			
Slewing speed	12 deg / sec			
Lifting speed at max outreach	0.44m/sec	0.57m/sec	0.71m/sec	0.84m/sec
Height in folded position	2,800mm	2,800mm	2,800mm	2,800mm
Width in folded position	2,550mm	2,550mm	2,600mm	2,700mm
Installation width needed	1,200mm	1,200mm	1,200mm	1,200mm
Weight	2,520kg	2,680kg	2,820kg	2,930kg

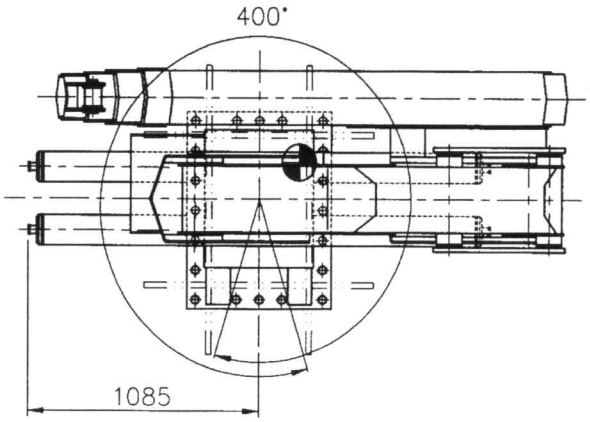
1) Lifting capacity at +20 ~ -25° innerboom position

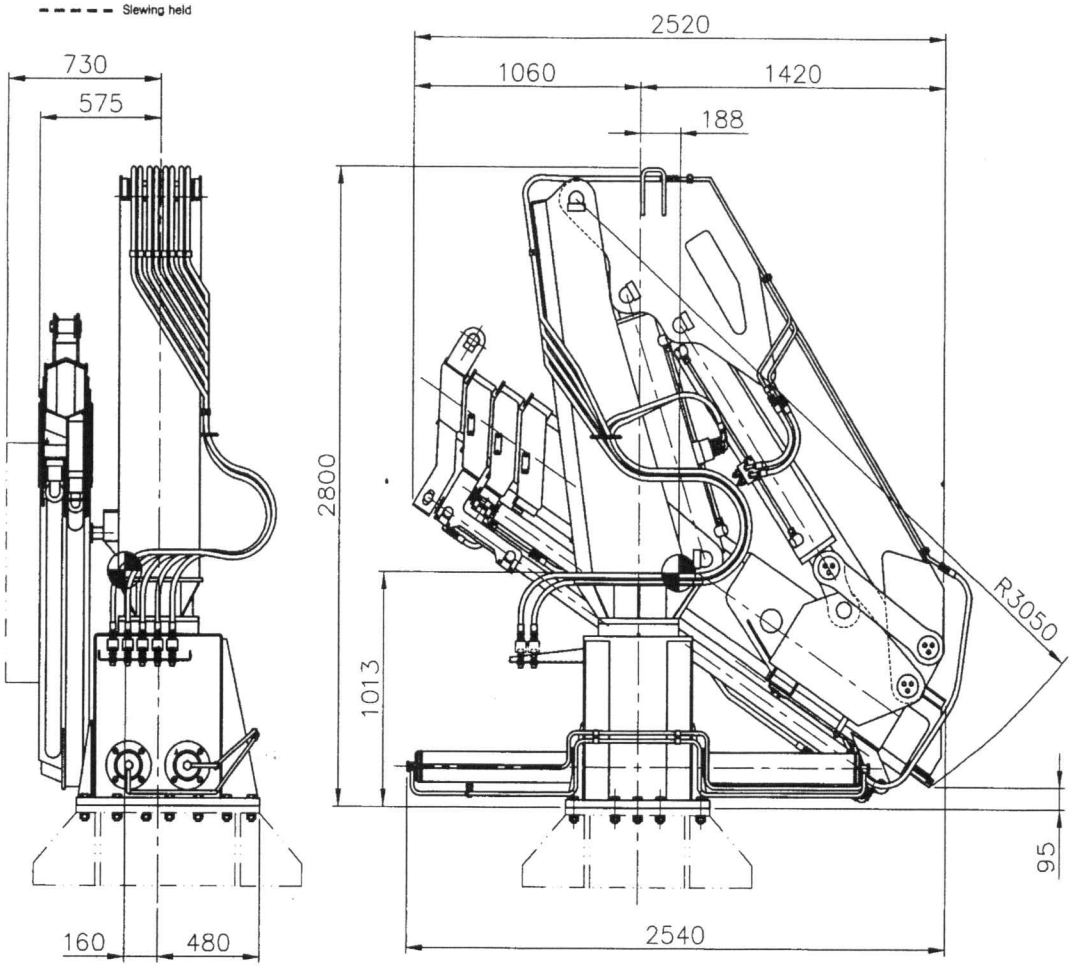
2) Designed and strength calculated in accordance with DIN 15018, crane group H1/B3

★ Note: We reserve the right to change technical specification without prior notice.

Hiab 201 **Outline View**

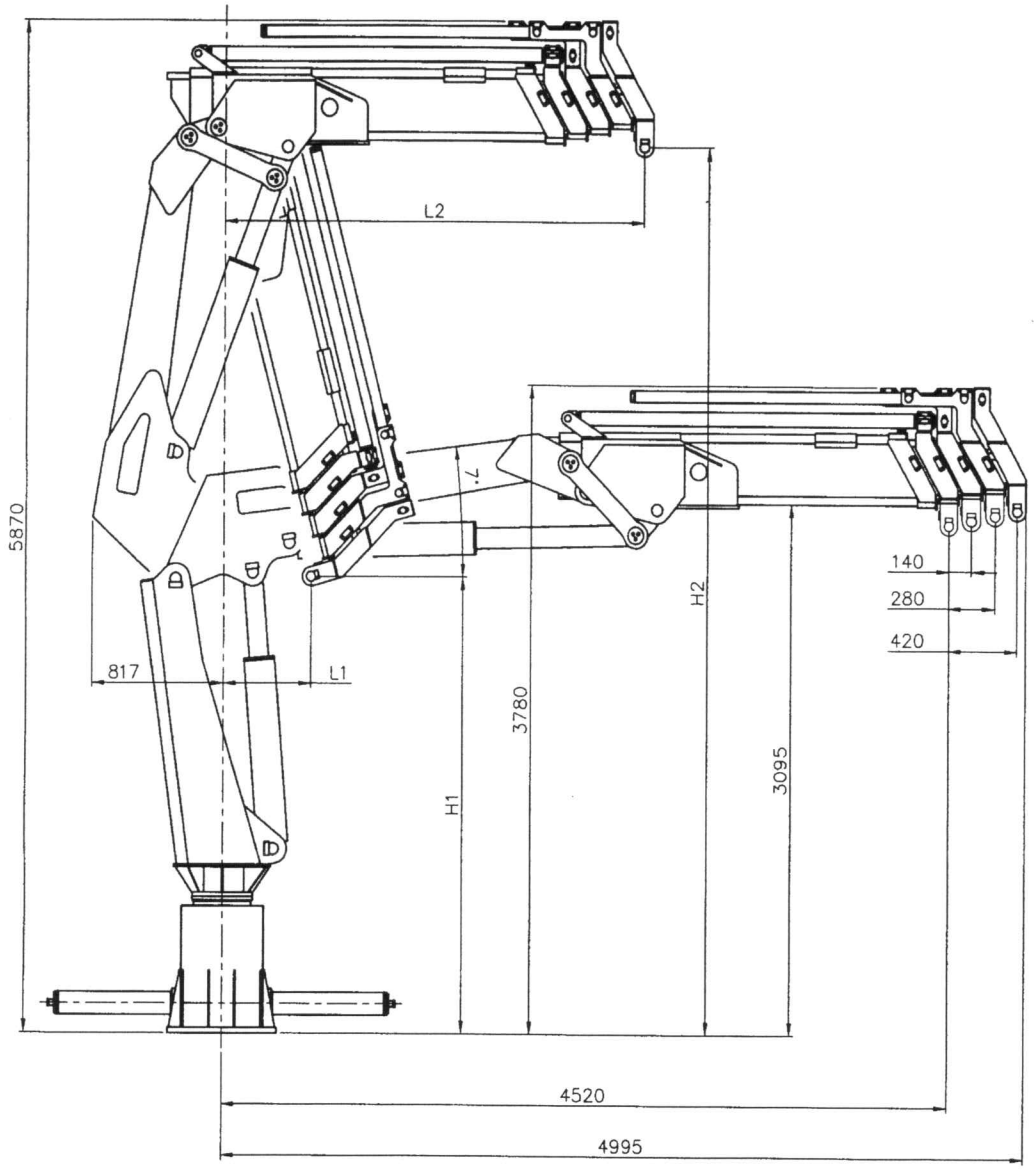






★ Note: We reserve the right to change technical specification without prior notice.

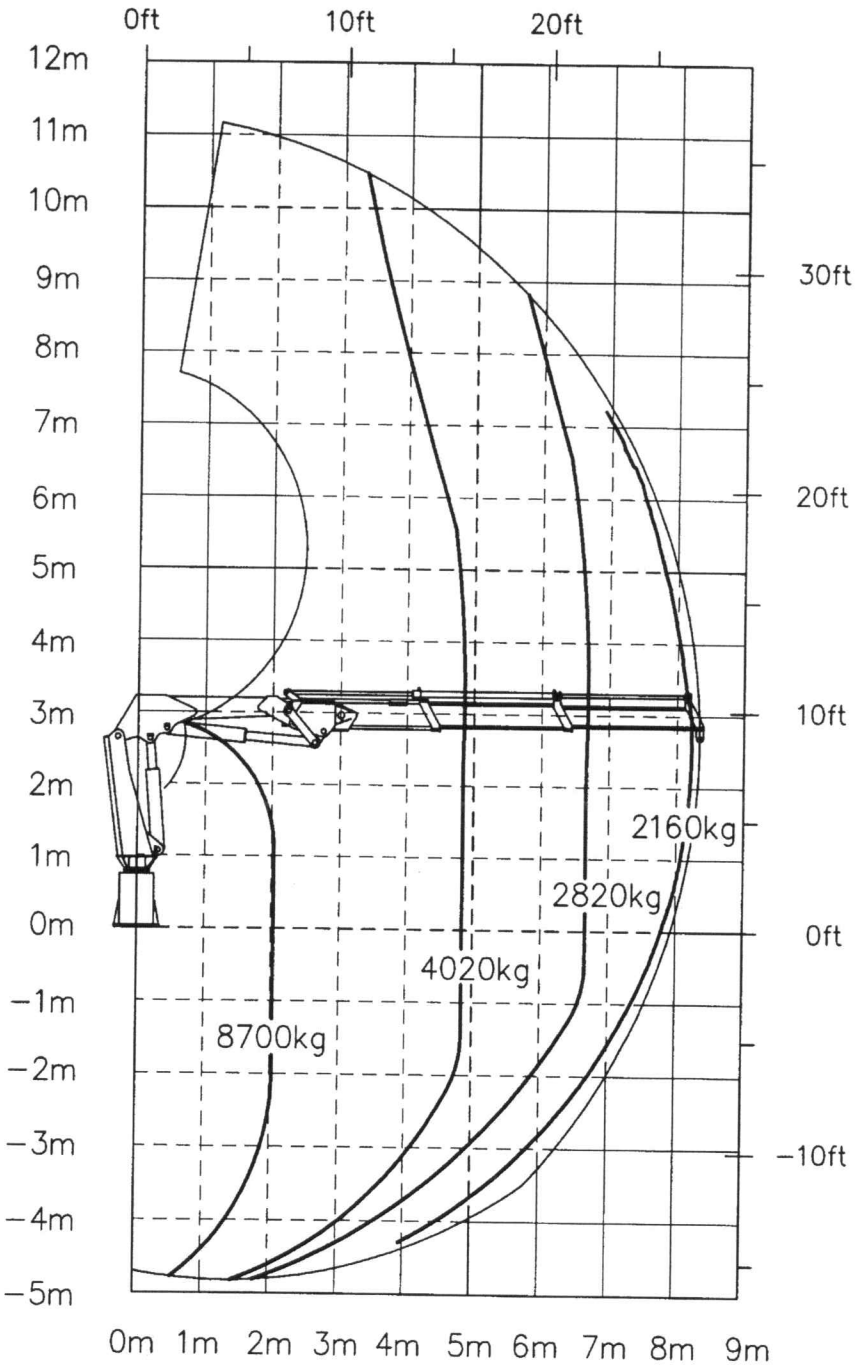
Hiab 201 **Dimension**



	L1	H1	L2	H2
HIAB201-1	350	3035	2197	5157
HIAB201-2	415	2910	2337	5127
HIAB201-3	480	2785	2477	5097
HIAB201-4	545	2660	2617	5067

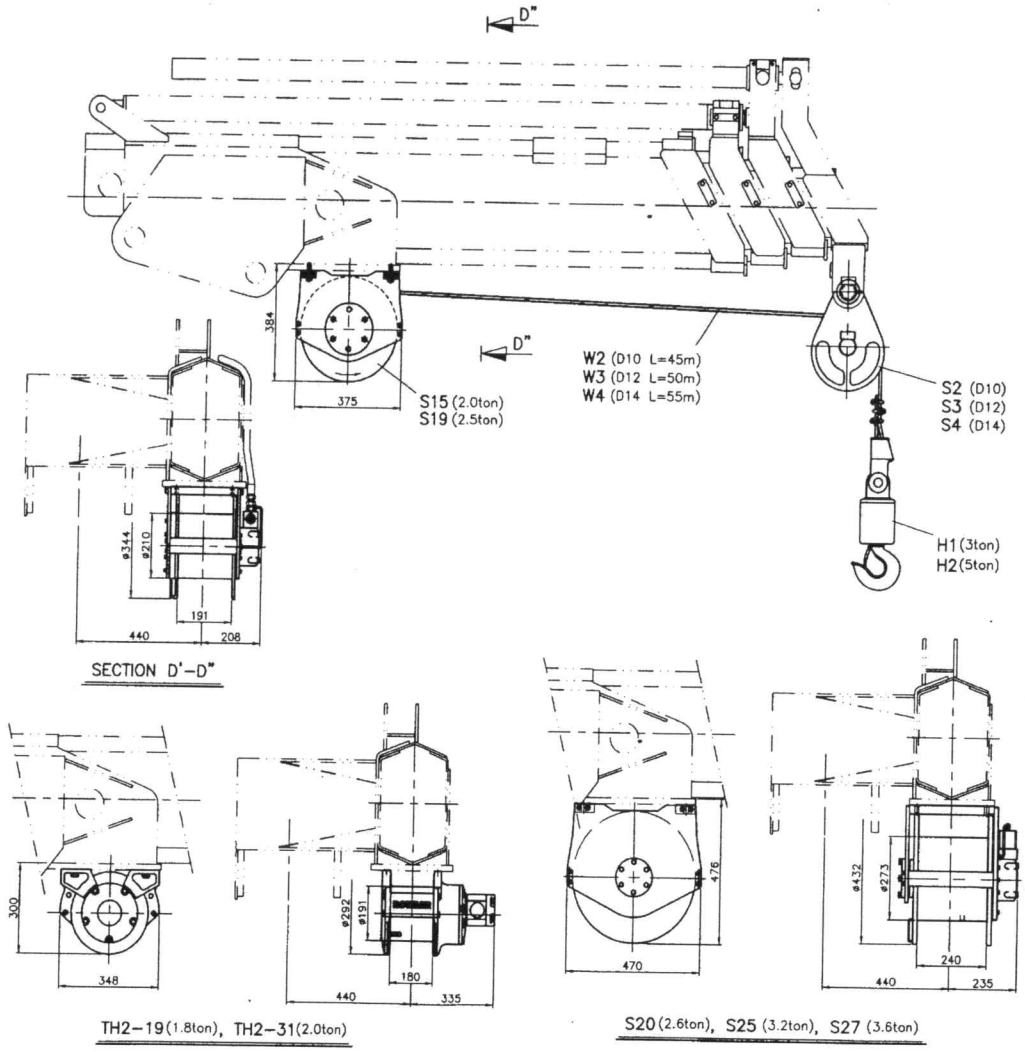
★ Note: We reserve the right to change technical specification without prior notice.

Hiab 201-2 **Lifting capacity**



★ Note: We reserve the right to change technical specification without prior notice.

Hiab 201 **Winch installation**



	TH2-19	TH2-31	S15	S19	S20	S25	S27	Remarks
SPEC	1.8 ton	2.0 ton	2.0 ton	2.5 ton	2.6 ton	3.2 ton	3.6 ton	at bare drum
	1.4 ton	1.5 ton	1.5 ton	1.9 ton	2.1 ton	2.5 ton	2.7 ton	at full drum
WEIGHT	77 Kg	77 Kg	77 Kg	78 Kg	154 Kg	154 Kg	155 Kg	

	W2	W3	W4	S2	S3	S4	H1	H2
SPEC	10*45m	12*50m	14*55m	D10	D12	D14	3ton	5ton
WEIGHT	20 Kg	31 Kg	47 Kg	12 Kg	15 Kg	20 Kg	25 Kg	35 Kg

★ Note: We reserve the right to change technical specification without prior notice.