68-34
copy 2

WOODS HOLE OCEANOGRAPHIC INSTITUTION

REFERENCE NO. 68-34

CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM

by

Jonathan Leiby

*This document has been approved for public release
and sale; its distribution is unlimited.*

WOODS HOLE, MASSACHUSETTS

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

REFERENCE NO. 68-34

CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM

by

Jonathan Leiby

May 1968

TECHNICAL REPORT

*Submitted to the Office of Naval Research
under Contract N00014-66-CO241, NR 083-004.*

*Reproduction in whole or in part is permitted
for any purpose of the United States Govern-
ment. In citing this manuscript in a bibli-
ography, the reference should be followed by
the phrase: UNPUBLISHED MANUSCRIPT.*

*This document has been approved for public
release and sale; its distribution is unlimited.*

Approved for Distribution

Arthur E. Maxwell
Associate Director

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM

by

Jonathan Leiby

Prepared for the Second Technical Conference
held by the Food and Agriculture Organization
of the United Nations in Seattle, May 1968

May 1968

JONATHAN LEIBY

CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM

1	INTRODUCTION	1
2	REVIEW OF EXISTING SYSTEMS	2
	2.1 Background	2
	2.2 The CALYPSO Yumbro Crane	2
	2.3 The Westinghouse Tender Crane	2
	2.4 The Electric Boat System	2
	2.5 Ocean Systems "Sea Lift"	3
	2.6 The ALVIN Catamaran System	3
	2.7 Other Systems & Summary	3
3	DEVELOPMENT OF BASIC REQUIREMENTS	4
4	DEVELOPMENT OF THE SPECIFICATIONS	4
5	SUMMARY OF THE SPECIFICATIONS	5
6	SPECIFIC FEATURES	5
	6.1 System Capacity	5
	6.2 Motion Conditions	5
	6.3 Automatic Hook-up	6
	6.4 The Hoisting System	6
7	CONSTRUCTION AND CONCLUSION	6
8	REFERENCES	7
9	APPENDIX	8

1 INTRODUCTION

One of our greatest present limitations is the handling of heavy oceanographic equipment in the rough seas that prevail so much of the time. The ability to handle heavy equipment in rough winter weather at sea is a necessary goal that has received very little theoretical or practical treatment compared to its importance in research, salvage, and rescue work. The transfer of large oceanographic equipment has gained great importance in Woods Hole with the acquisition of the deep submergence oceanographic research submarine ALVIN. This fifteen ton craft (Mavor, J.W. et al, 1966) requires launch and recovery and service from a surface support vessel and its handling has proven to be a difficult task at best.

One of the major reasons for a change in the design of the Navy's medium size AGOR class research ships was to provide the capability to carry small submersible research vehicles and similar heavy objects. With the assignment of one of the first of these new vessels, the AGOR-15, to the Woods Hole Oceanographic Institution (Leiby, 1967), where ALVIN is in operation and another submersible is scheduled for delivery in 1969, it became imperative that the ship not only be capable of carrying such a load but that an adequate handling system be developed.

The funding for the design and construction of the new AGOR provided the opportunity to survey the state of the art and to develop and improved handling system for ALVIN.

2 REVIEW OF EXISTING SYSTEMS

2.1 Background

Conventional cargo gear, developed for loading in port, suspends the weight on long wires which can lead to rather violent motion and damage when used at sea on a rolling ship. Use of this type of equipment has had the effect of inhibiting the handling of much equipment at sea. With the sole exception of the method used by the 19th century whalers in the launch and retrieval of whaleboats, where hand operated falls provided constant tension hoisting, and pulling against the side of the ship on skids provided motion control, the author knows of no system developed for the controlled handling of heavy weights at sea until Cousteau's adaption of the Yumbo crane on the CALYPSO about 1958.

2.2 The CALYPSO Yumbo Crane

Cousteau (1963), handling a small submersible from the research vessel CALYPSO, has utilized an hydraulically articulated crane from the stern of that ship. To eliminate any pendulum effect the hook is attached directly to the articulated boom section of the crane and the hook is then attached to a bridle with a very small clearance of one or two feet above the submersible. Manual connection and release of the hook from the bridle is accomplished by divers. This system has provided firm control of the motion of the submersible during launch and retrieval necessary to prevent swinging against the ship and has also allowed the placement of the submersible in a rather small hold below decks without damage. Because the CALYPSO system has had its principal use in the Mediterranean and similar calm sea areas, the problem of damage during surging of the submersible from the relatively short distance between the hook and the submersible has been generally avoided.

2.3 The Westinghouse tender crane

An adaption of the CALYPSO system has been utilized from the stern of the tender from which the Westinghouse submersibles are attended. Again an articulated crane is utilized with a similar bridle on the submersible with manual hook-up provided by divers. One major change in the Westinghouse system over that of the CALYPSO has been the addition approximately three or four feet of hook travel with the hook actuated by a hydraulic cylinder attached to the articulated end of the boom (See Shenton 1965).

2.4 The Electric Boat System

The system is used by the Electric Boat division with their submersibles of the Star series has adapted a normal crane operated over the stern of the tending vessel (Pitchersky, 1968). The hook is lowered on a two part block in a normal fashion. However, two air winch powered vans lines have been provided on a wide base frame attached to the base of the crane so that their action at 90° to each other can control the swinging of the hook block. In this installation, the prevention of shock loading when picking up the submersible in a heavy sea is dependent upon the response of the operator in manipulation of the hook. It would seem that the two part wire hoist line gives a slower response than the direct control of the boom associated with the other systems.

2.5 Ocean Systems "Sea Lift"

In the handling system developed by E. Link for Ocean Systems, a marine crane has been modified into a configuration similar to the CALYPSO's crane, with the major addition of a fairly long hook line operated by an high-speed hydraulic system. Once the submersible is connected to the hook, it is removed from the sea at a rapid rate. The timing for this action (hopefully when the submersible is on top of a wave) is controlled by the operator. Careful timing by the operator and the high speed action available are utilized to avoid shock loadings on the submersible (Pitchersky, A., A. Southerland, 1968).

2.6 The ALVIN Catamaran System

Unfortunately, the design specifications and construction of ALVIN gave little consideration to handling of the boat at sea. It developed that the bottom skids were the strongest and most accessible part of the framework and thus it was better to lift by the bottom than to use a bridle from the relatively fragile pad eyes on top of the submersible. Fortunately two large surplus minesweeping pontoons became available and they were made into a catamaran barge tender which could hoist ALVIN on an elevator-like platform between the hulls (Mavor, 1966). The method of launching and recovery from the catamaran has consisted of running the submersible between the hulls and over a platform suspended by four wires. The submersible is positioned both by its own propulsion and six men tending tag lines attached by swimmers. When properly positioned the cradle platform is raised by the four wires at its corners. When the platform is in the water, it swings freely but as it is raised it becomes restrained by engaging guides on the side of the catamaran. The winch system operates at a slow speed and consequently there are times in rough seas when the first contact with the submersible is abrupt. This system has been operational because the catamaran has usually only been used in fairly calm seas and the semi-submerged design of the catamaran provides ship motions rather similar to those of the submersible so that mating the two has not been as difficult as it would be on a more high sided and buoyant normal catamaran ship form. Time and funds have not permitted the development of a soft constant-tension drive for the cradle hoist but this is expected to be remedied in the future. In summary then, the ALVIN system provides for a measure of automatic hook-up by having a cradle rise under the boat, and a measure of motion control by the characteristics of the catamaran and use of guides as the cradle rises.

ALVIN has also been launched and recovered on several occasions by being lifted with a crane from its top-side padeyes. In these instances, the cranes utilized were intended for other purposes with no constant tension or quick acting features available to reduce the loads imposed by surging of the submersible in a seaway, and no features were available for the automatic hook-up or quick release of the boat once it was afloat. Such a trying exercise has been described by Barringer (1966).

2.7 Other Systems and Summary

At Lockheed, a U shaped ship, or a catamaran with its forward end closed, has been built as a tender for the submersible DEEPCQUEST. It is understood that the handling system is basically similar to that used for ALVIN although no details have been given in the literature.

The U. S. Navy had various studies developed for its Deep Submergence Systems Project (DSSP) for handling its relatively large rescue submersible. These schemes encompassed everything from submerged tenders with underwater retrieval to a "fork-lift" design over the side of a normal surface vessel. The final design selected for use with the large ASR surface catamaran is a system again much like that developed for ALVIN, but the submersible is attached automatically underwater. This has been described in detail by Pitchersky and Southerland (1968).

In summary, there has been little real advance in the state of the art of handling heavy objects at sea since Cousteau's development in 1958. Most of the systems described have been efforts to control the swinging motions of a suspended load. The problem of constant tension or a soft lift has either not been dealt with or has been intentionally avoided; most of the systems are confined to relatively calm and warm ocean or near shore areas. The problem of automatic hook-up has only been crudely addressed by the cradle-lift system and the presence of swimmers is still required. There is no system in operation which can routinely launch and retrieve small submersibles with a weather capability comparable to the handling of aircraft on an aircraft carrier.

3 DEVELOPMENT OF BASIC REQUIREMENTS

In developing the requirements for the system associated with the AGOR-15 three basic requirements, generally absent in any existing handling system, were considered to be mandatory. One is the provision for constant tension means to allow for the surging of the submersible in a seaway and to thereby reduce or prevent shock loading on both the submersible and the lifting device. The second is the provision of an automatic release and hook-up system to normally eliminate the need for personnel and the submersible to be endangered during the launch and recovery connection process. The third is the provision of a means to control the motion of the submersibles, particularly the pendulum action, when suspended vertically from a ship in a seaway.

In addition to these three requirements, consideration had to be given to utilization of this system with a specific submersible, namely ALVIN, which is operated by Woods Hole. Since the most rugged structure this particular submersible is in the skids under the hull, it would be preferable to apply any shock loading at that point rather than to the more fragile padeyes topside. However, considering that the shock loadings would be reduced or substantially eliminated by the provision of proper constant tension features, and considering the difficulty in providing an automatic connection system under the submarine utilizing the skids, it was determined that the system should attach to a pick up point provided above the submarine utilizing the padeyes.

Having thus established the basic requirements detailed studies for the system were developed in conjunction with the specifications for the ship itself which was under design by the Navy.

4 DEVELOPMENT OF THE SPECIFICATIONS

The first two attempts were developed from early handling studies made for the DSSP project. One consisted of a rather elaborate hydraulic fork-lift transfer system extended

over the stern of the ship. The other was a hinged pair of davits arranged amidships. By inspection neither of these schemes were judged to be practical and were rejected. The third attempt, developed by a farm-out design office, was worse and was rejected by the Navy as well as the operators. This scheme portrayed a simple heavy-duty set of boat davits with a strongback between, no provisions to meet the three basic requirements, and was obviously developed from lifeboat davit considerations where there is no legal obligation to retrieve the boat or even to get it into the water without shock.

A subsequent study of various existing systems, especially ALVIN experience and Cousteau's experience, led to the development, by the author and A. Pitchersky of the Navy's Ship Engineering Center, of the specifications reprinted in the Appendix.

5 SUMMARY OF THE SPECIFICATIONS

The specifications were presented as performance requirements rather than as a completed engineering design. Detail development is required of the contractor to the operator's approval.

The specified handling system consists of (1) and hydraulic crane with the added capability of automatic hook-up, constant tension (soft) hoisting, and constant control of load (submersible pick up point) motions (pendulum and azimuth), (2) extensive pneumatic rubber fendering of the side of the ship, and (3) a shelter in which to overhaul the submersible and change batteries. Within the limits of its capacity, and the capacity of the ship, the system can handle any number of submersibles. The entire system is intended to be completely detachable from the ship so that it will not interfere with other uses of the ship and may be used on other ships and suitable platforms.

6 SPECIFIC FEATURES

6.1 System capacity

Although specified for a 20 ton (40,000 pound) submersible the requirement was later changed to 25 ton (50,000 pounds) to accommodate a slightly heavier "sister" submersible to ALVIN.

6.2 Motion conditions

The constant tension devices and motion restraining devices (swing and azimuth) are specified to function in 8 foot waves (sea state 4-5) while the ship is rolling 10 degrees and pitching $3\frac{1}{2}$ degrees. Although not specified this works out to a total relative rise and fall of approximately 18 feet (6m).

During hoisting under such conditions, the constant tension device is required to limit the load on the "hook" to less than 1.5 times the rated load. The motion restraining device will permit vertical heave due to sea and rolling conditions while restraining horizontal motion. This is quite different from the articulated Yumbo concept wherein violent heaving the submersible could be damaged by the vertically oriented articulated boom.

6.3 Automatic Hook-up

The automatic hook-up is to be accomplished by attaching a 'tag' line to the main lift point of the submersible. This line will be a light line (3/4 inch nylon) with no metallic parts such as thimbles to endanger personnel, and will act as a pull-down line for the main hook. Attachment of the nylon line will initially be by the operator in the submersible or swimmers, but will be accomplished from the ship after initial trials are completed. The main hook-up connection will be made automatically under constant tension conditions as the nylon pull-down line brings the hook and the submersible together.

6.4 The Hoisting System

The hoisting system, incorporating the constant tension device, will give the following results: Prior to hoisting the submersible will be in vertical motion due to a combined action of the ship's motion and its own motion in a seaway. The main hoisting line shall be taken in and paid out as fast as the boom head of the crane and the submersible move toward and away from each other. When the lift is commenced, constant tension feature shall be locked in payout but still provide overhauling to prevent slack line if the vehicle should rise faster than the hoisting speed. The hoisting mechanism is designed to require a minimum of inertia to accomplish these functions.

The auxiliary restraining device will permit vertical motion as a result of the constant tension feature while restraining horizontal motion due to the rolling and pitching of the ship and the motion of the submersible in a seaway. The amount of restraint is to be remotely controlled by the operator to provide the necessary dampening.

7 CONSTRUCTION AND CONCLUSION

These specifications are incorporated by the Navy into the construction specifications for the AGOR-15 ship and it thus became the responsibility of the shipbuilder to produce the handling system. To this end, the shipbuilder contracted with the Northern Line Machine and Engineering Company of Tacoma who have proceeded with the detail and design and construction.

While the equipment will not undergo sea trials until delivery of the AGOR-15 in 1969, it is felt important that it be described now that its rational, requirements and engineering design are fixed in order to make known to the oceanographic and engineering community what is under development. Because a disproportionate amount of effort has been put into the engineering development of small submersibles compared to that devoted to the problems of handling such vehicles at sea we have a situation where this lack is a large obstacle in submersible operations. The system herein described, as well as some of the other systems reviewed have been specific in constructive steps to rectify this situation. The described system may not solve all the problems but is deemed important to foster discussion to make users more aware of what the problems are, what is going on and what appears to be possible in this field. It is hoped that such discussion will inhibit the repetition of devices or systems which are known to be inadequate and will encourage others to try new approaches to the problem. Only by each making different logical experiments can we begin to arrive at solutions.

The author would like to emphasize in conclusion that it is not considered that the system here described is any way a final solution to the handling problem of large equipment on a research vessel in the seaway. It is probable that different methods will be better for different devices or for use under widely different circumstances. Hence, it is hoped that other investigators will attempt to develop other approaches to the handling of large objects at sea. It would be well if, with the limited resources that are generally available to work on such problems as these, others take advantage of our opportunities to approach different solutions to such basic and important problems in oceanography.

8 REFERENCES

- Mavor, J. W., H. E. Froehlich, W. M. Marquet, and W. O. Rainnie, ALVIN, ...1966..... 6000-ft. Submergence Research Vehicle, Trans. Society of Naval Architects and Marine Engineers, vol. 74: 106-149
- Leiby, J. New Ship Design AGOR-15, Oceanus, vol. 13(2 & 3): 17-19
...1967.....
- Cousteau, J. Y., The Living Sea. New York, Harper & Row, 325 P.
...1963.....
- Shenton, E. H., Tempest in a Saucer, Geo-Marine Technology, vol. 1 (10), ...1965..... 334-336.
- Mavor, J. W., Jr. Ten Months with ALVIN, Geo-Marine Technology, vol. 2 (2), ...1966..... 40-50.
- Pitchersky, A., A. Southerland, Handling Problems at the Ocean-Air Interface, ...1968..... Chesapeake Section, Soc. Naval Arch. & Marine Engineers, Jan. 16, 1968.
- Barringer, J. L., Jr., Cubmarine Operations in Spain. Geo-Marine Technology, 3 (1): 12-18.
...1966.....

DEEP RESEARCH VESSEL (DRV) HANDLING EQUIPMENT

General.—Provide a hydraulic crane for DRV handling capable of safely launching and retrieving DRV's weighing up to 20 tons, in the sea conditions specified under 'Performance.' The crane shall provide positive control and be capable of safely topping, slewing and hoisting under these conditions.

The crane equipment shall include control of shock loading of the vehicle and restraint of the motion of vehicle while hoisting and landing on deck. Special fendering shall be provided for protection of the vehicle and hull during the handling operation. The equipment shall meet applicable requirements of 9200-4. The crane shall be a modified Pettibone-Mulliken "Multikrane," Bucyrus-Erie "Hydrocrane," Grove TM Series crane or approved equivalent.

Performance.—The system shall lift a 20 ton DRV (with approximate dimensions of 22 feet length 8 feet beam 13 feet height overall) from the water surface 8 feet from the side of the ship to a position 5 feet above the main deck at the stowage location.

The system shall provide a main hoist to take full weight of the DRV and an auxiliary motion-restraining device which shall not carry load. The main hoist shall lift 40,000 pounds at a minimum speed of 40 feet per minute.

The force on the main hoist, due to dynamic factors, shall not exceed 30 tons (1.5 times the DRV weight) during the hoisting procedure under the following conditions:

The DRV, in the water, is responding to 8 foot waves and the ship is rolling 10 degrees and pitching 3-1/2 degrees at the period calculated for the ships motion in each direction. To accomplish this the hoisting system (winch) shall incorporate one or a combination of constant tension devices similar to an auxiliary constant tension ratchet winch, a differential drive with one main and one constant tension input, an elastic rope (such as nylon), or other approved system to give the following results:

Prior to hoisting, when the DRV is in vertical motion due to action of the seaway, the line shall be taken in and paid out as fast as the boom head and the DRV move toward and away from each other. When the lift is commenced, the constant tension feature shall be locked in payout but still provide overhauling to prevent slack in the line if the vehicle should rise faster than the hoisting speed. The

no load hoist speed shall not be less than 300 feet per minute. This unidirectional locking of the constant tension feature shall be accomplished by a Formsprag, eddy current, or similar clutch system with due regard to inertia reaction of the system. A shock absorber shall be fitted to the hoist system to take up any remaining shock that might result from lags in the above system.

Connection to the DRV hoisting strongback shall be thru an automatic hook-on device with release control by lanyard from a remote location. Attachment of the hoist connection device to the DRV hoisting strongback shall be accomplished with an auxiliary pull-down device with sufficient power to overcome the constant tension in the main whip. Connection of the auxiliary pull-down device leader shall be accomplished by personnel in the DRV and due regard shall be given to provision for a light, safely handled leader, hook and main whip termination.

The restraining device shall consist of a light hinged structure, one end attached to a hydraulic dampening device on the main boom section and the other attached to the hoist connection device in such a way as to prevent major transverse or longitudinal excursions of the connection device through action of a hydraulic dampener or other mechanism but to permit vertical movement when attached to the DRV.

The restraining device shall be remotely controlled to provide the necessary dampening of pendulum motion of the DRV during the full range of operational conditions.

The length of the arm shall be a maximum consistent with DRV operations and dimensions and shall allow the connection device to two-block at the boom when the latter is in the hoisting position.

The connection device shall be attached to the DRV hoisting strongback in a manner which shall prevent any relative motion between the two pieces. The restraining device shall be used to dampen pendulum motion during the full range of operating conditions when the crane is trained outboard. When the crane is revolving or in position over the DRV stowage location the restraining device shall be in a two-blocked position. The restraining device shall be designed for a side load at the connection device due to a 10-degree angle of the hoist line caused by misalignment of the DRV under the hoist. The DRV stowage shall be

Appendix

positioned so that lowering the crane boom will center the hoist in the proper hoisting position over the DRV.

A hydraulic rotator shall be attached to the end of the arm and shall be designed to connect to the main hoist connection device in such a way that it may be operated remotely from the crane base. It shall be capable of rotating the DRV in order to maintain the DRV in proper alignment during the handling operation. Provision shall also be made to lock the arm in a stowed position out of the way. Design and construction of the arm shall allow a man to climb out on it to service the main connection device and the rotor.

In that simultaneous use is not intended, the requirements for the Medium Crane specified elsewhere may be incorporated into the DRV Handling Davit and one unit furnished upon approved assurance that both requirements can be met without voiding or complicating each use as intended.

The crane shall be a hydraulically operated full revolving unit on a stationary mounting. The turntable shall rotate hydraulically 380 degrees by means of a hydraulic motor in conjunction with a gear reducer unit.

The boom shall be raised and lowered as well as extended and retracted using hydraulic cylinders.

Raising and lowering of the cable hook shall also be hydraulically controlled by the use of a vane type hydraulic motor in conjunction with a gear reducer unit.

Foundations.—All handling and stowage equipment shall be removable and bolted on foundations with adequate structural reinforcement and designed so that the deck will be flush when all bolted fittings are removed.

Provision shall be made to mount the crane at about frame 67 and frame 87 with underdeck foundations arranged to give the required support to the bolt-down fittings and carry the load to the first platform and into the ships structure. The portion of the foundations between the main deck and first platform shall be designed to provide useful space for such purposes as lockers. The crane pedestal shall have a minimum clearance of 12 inches from the rail.

All cleats, padeyes, fairleaders, and other fittings shall be provided as necessary to insure the efficient handling of the DRV, and the most advantageous leads.

Provide power operated winches to handle the DRV tending lines. Provide fittings, fenders, lashing and all necessary lines, to safely handle

the DRV between its stowage and the water during the conditions of ships motion outlined under "performance."

Sheaves, bearings, and means of lubrication shall comply with the appropriate specifications. Plain bearings shall have bronze bushings, and the bushings shall have positive means to prevent turning. All bearings shall have pressure grease lubrication. Where pressure lubrication cannot be used, the design shall permit repacking during overhaul.

For the design of sheaves, drums, and other features of wire rope installations not covered herein, the data given in Bureau of Ships Technical Bulletin No. 5 represents acceptable procedures. Tread diameter of sheaves shall be not less than 14 times the diameter of the wire rope used. Sheaves shall be shrouded to keep the rope in place under all conditions.

The controls shall be grouped together to permit ready operation by one man, and shall be so located as to afford the operator a clear view of the DRV handling operation.

Stowage shall be in cradles supplied with the DRV and shall be fitted to the standard deck bolt-down fittings. Provide lashing and the tie down fittings necessary to prevent movement of the stowed DRV in the storm conditions outlined in 9020-0.

DVR shelter.—A portable light corrugated aluminum shelter with a roll-down door shall be provided and bolted to the deck to permit servicing of the stowed DRV. The shelter shall meet U. S. Dept. of Commerce Weather Bureau specifications SF-458.4-2 except that the size shall be 30 feet wide, 12 feet deep, and 20 feet high and the door opening shall be 25 feet wide and 18 feet high.

All portable fittings shall be provided with stowages in portable deck boxes close to the DRV stowage location.

The bulwark section between frames 79 and 87, starboard, shall be removable similar to the removable bulwark specified in 9110-0.

The complete installation shall comply with all applicable sections of these specifications even though not specifically stated herein. Water, diesel fuel and normal ships electrical power shall be provided as necessary to service the DRV.

Fendering.—To protect the DRV when coming along side and during hook-up, inflatable rubber/neoprene mat type fenders shall be provided on the shell by use of bolt-down shell fittings specified in 9120-5. Fenders shall be three U. S. Rubber Co. Uniroyal Sealdtank, or equal, 30 feet by 7 feet, of six ply construction, each furnished with five nylon

Appendix

20,000 pound rating webbing straps, of sufficient length to reach the main deck, and eye pads and grommets to lash fenders to side of ship by means of bolt-down-fittings. The fenders shall be designed to be filled with both water and/or air.

Electrical Installation.—Motors associated with the handling shall not be loaded beyond the motor manufacturers full load rating during the vertical lift. All connections, motors and controllers shall be protected from physical injury as necessary.

Automatic means shall be provided to prevent the hoisting and lowering operations from exceeding safe limits of travel.

Guards shall be provided over equipment which is hazardous to personnel.

Power Requirements.—Provide two sources of power for the DRV handling equipment, one source from the ship service switchboard, and one from the quiet ship generator switchboard. Provide manual bus transfer for source selection. These requirements modify Plan, BUSHIPS No. AGOR14-800-2502361.

Motors and Controllers.—Motors and controllers shall be in accordance with 9630-1 and the following classification data.

Motor

No. per Ship	1
HP Full Load	As required
Speed	As required
Voltage	440
No. of Phases	3
Design	D
Duty	Short time (15 min)
Amb. Temp. C°	40
Enclosure	As required by USCG

Controller

Type	Across Line
Operation	Magnetic
Volt. Protection	LVP-Remote Emergency Run
Enclosure	As required by USCG

Master Switch

Type	PB
Location	Local
Enclosure	As required by USCG

Tests.—Crane installation, including motors, and controllers, shall be tested in accordance with 9020-11, and as stated herein. Motors and controllers shall also be tested in accordance with 9630-1, after installation. Any hand operating gear shall be tested manually at least once and as necessary thereafter to demonstrate satisfactory operation.

The above referenced test requirements shall be supplemented as follows:

No Load.—The no load test shall be carried out with no cable on the drums. No abnormal heating of any part shall occur when operated continuously, alternately in each direction without load, for one-half hour at rated speed.

Load Test.—The crane and the associated equipment shall be given a dynamic test at 200 percent of the rated load, with the crane in the outboard position. The test load shall then be lowered and intermittently stopped. No permanent set shall result. (Note: The lowering and intermittent stopping of the 200 percent rated load is specified in lieu of a shock test, to demonstrate the ability of the crane to withstand the dynamic loads imposed when handling the DRV under unfavorable sea conditions.)

In no case will the crane be required to lift the 200 percent rated load test weight.

Overload.—The crane shall hoist and lower the 150 percent rated load test weight through at least four complete cycles between the water and the stowage position.

Rated Load.—The crane shall hoist and lower the rated load through at least four complete cycles between the water and the stowage position.

All fittings used for securing the DRV in stowage position, either on ship's structure or on crane, shall be tested by stowing and unstowing the DRV to demonstrate satisfactory fit and operation.

Painting.—The crane and all components, etc., shall receive one coat of inorganic zinc type coating, and two coats of finish paint as specified in 9190-1.

Stress Diagrams.—The Contractor shall submit plans showing stress diagrams for the crane installation, or in accordance with 9020-1.

Technical Manuals.—Technical manuals shall be provided in accordance with 9120-5.

Plans.—Provide plans showing the DRV handling system in various stages of operation, locating the fittings and lines to be used at each stage.

AGOR-15

DRY HANDLING

SCALE 1/8"=1'-0" SHEET 1 OF 3

UNCLASSIFIED TECHNICAL REPORTS DISTRIBUTION LIST
FOR OCEANOGRAPHIC CONTRACTORS
OF THE OCEAN SCIENCE & TECHNOLOGY GROUP
OF THE OFFICE OF NAVAL RESEARCH
(Revised February 1969)

DEPARTMENT OF DEFENSE

Director of Defense Research and
Engineering
Office of the Secretary of Defense
1 Attn: Office, Assistant Director
(Research)
Washington, D. C. 20301

NAVY

- 2 Office of Naval Research
Ocean Science and Technology Group
Department of the Navy
- 1 Attn: Surface & Amphibious
Programs (Code 463)
- 1 Attn: Oceanic Biology (Code 408-B)
- 1 Attn: Undersea Programs (Code 466)
- 1 Attn: Field Projects (Code 418)
- 1 Attn: Geography Branch (Code 414)
Washington, D.C. 20360
- 1 Commanding Officer
Office of Naval Research Branch Office
495 Summer Street
Boston, Massachusetts 02210
- 1 Commanding Officer
Office of Naval Research Branch Office
219 South Dearborn Street
Chicago, Illinois 60604
- 3 Commanding Officer
Office of Naval Research Branch Office
1030 East Green Street
Pasadena, California 91101
- 1 ONR Resident Representative
University of California, San Diego
P.O. Box 109
La Jolla, California 92037
- 5 Commanding Officer
Office of Naval Research Branch Office
Navy #100, Fleet Post Office
New York, New York 09510

- 6 Director
Naval Research Laboratory
Attn: Code 5500
Washington, D.C. 20390
- 2 Commander
U. S. Naval Oceanographic Office
- 1 Attn: Code 1640 (Library)
- 1 Attn: Code 031
- 1 Attn: Code 70
- 1 Attn: Code 90
Washington, D.C. 20390
- 1 West Coast Support Group
U. S. Naval Oceanographic Office
c/o U. S. Navy Electronics Laboratory
San Diego, California 92152
- 1 U. S. Naval Oceanographic Office
Liaison Officer (Code 332)
Anti-Submarine Warfare Force
U. S. Atlantic Fleet
Norfolk, Virginia 23511
- 1 Chief
Naval Ordnance Systems Command
Department of the Navy
Washington, D. C. 20360
- 1 Commander-in-Chief
Submarine Force Pacific Fleet
Fleet Post Office
San Francisco, California 96610
- 1 Commander-in-Chief
Pacific Fleet
Fleet Post Office
San Francisco, California 96610
- Naval Oceanographic Office
Anti-Submarine Warfare Force, Pacific
Fleet Post Office
- 1 Attn: Commander
- 1 Attn: Liaison Officer
San Francisco, California 96610

Army

- 1 Coastal Engineering Research Center
Corps of Engineers
Department of the Army
Washington, D. C. 20310
- 1 Army Research Office
Office of the Chief of R&D
Department of the Army
Washington, D. C. 20310
- 1 U. S. Army Beach Erosion Board
5201 Little Falls Road, N. W.
Washington, D. C. 20016
- 1 Director
U. S. Army Engineers Waterways
Experiment Station
- 1 Attn: Research Center Library
Vicksbury, Mississippi 49097

OTHER GOVERNMENT AGENCIES

- 20 Defense Documentation Center
Cameron Station
Alexandria, Virginia 20305
- National Research Council
2101 Constitution Avenue, N.W.
- 1 Attn: Committee on Undersea Warfare
- 1 Attn: Committee on Oceanography
Washington, D.C. 20418
- 1 Director
Coast & Geodetic Survey - U. S. ESSA
Attn: Office of Hydrography &
Oceanography
Washington Science Center
Rockville, Maryland 20852
- 1 Director
Atlantic Marine Center
Coast & Geodetic Survey - U. S. ESSA
439 West York Street
Norfolk, Virginia 23510
- 1 Director
Institute for Oceanography
U. S. ESSA
Gramax Building
Silver Spring, Maryland 20910
- 1 U. S. ESSA
Geophysical Sciences Library (AD 712)
Washington Science Center
Rockville, Maryland 20852

- 1 Commanding Officer
Coast Guard Oceanographic Unit
Bldg. 159, Navy Yard Annex
Washington, D. C. 20390
- 1 Chief, Office of Marine Geology &
Hydrology
U. S. Geological Survey
Menlo Park, California 94025
- 1 Director
Pacific Marine Center
Coast and Geodetic Survey, ESSA
Seattle, Washington 98102
- 1 Geological Division
Marine Geology Unit
U. S. Geological Survey
Washington, D. C. 20240
- 1 National Science Foundation
Office of Sea Grant Programs
1800 G Street, N. W.
Washington, D. C. 20550
- 1 Bureau of Commercial Fisheries
Ocean Research Laboratory
South Rotunda, Museum Bldg.
Stanford, Calif. 94305
- 1 Bureau of Commercial Fisheries
U. S. Fish & Wildlife Service
P. O. Box 3830
Honolulu, Hawaii 96812
- 1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 3098, Fort Crockett
Galveston, Texas 77552
- 1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P.O. Box 1155
Juneau, Alaska 99801
- 1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 6
Woods Hole, Massachusetts 02543
- 1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 280
Brunswick, Georgia 31521

1	Director, Arctic Research Laboratory
Pt. Barrow, Alaska 99723	1	New Zealand Oceanographic Institute
Department of Scientific and
Industrial Research
P. O. Box 8009
Attn: Librarian
Wellington, New Zealand
1	Head, Department of Oceanography
University of Washington
Seattle, Washington 98105		
1	Director
Institute of Marine Sciences
University of Alaska
College, Alaska 99735	1	Director
Instituto Nacional de Oceanographia
Rivadavia 1917-R25
Buenos Aires, Argentina
1	Director
Bermuda Biological Station for
Research
St. Georges, Bermuda	1	Lieutenant Nestor C. L. Graneli
Head, Geophysics Branch
Montevideo 459, 4o "A"
Buenos Aires, Argentina
1	Director
Hawaiian Marine Laboratory
University of Hawaii
Honolulu, Hawaii 96825	1	Oceanographische Forschungsanstalt
der Bundeswehr
Lornsenstrasse 7
Kiel, Federal Republic of Germany
1	President
Osservatorio Geofisico Sperimentale
Trieste, Italy	1	Underwater Warfare Division
of the Norwegian Defense Research
Establishment
Karljohansvern, Horten, Norway
1	Department of Engineering
University of California
Berkeley, California 94720	1	Department of Geodesy & Geophysics
Columbia University
Cambridge, England
1	Applied Physics Laboratory
University of Washington
1013 N. E. Fortieth Street
Seattle, Washington 98105	1	Institute of Oceanography
University of British Columbia
Vancouver, B. C., Canada
1	Physical Oceanographic Laboratory
Nova University
1786 S. E. Fifteenth Avenue
Fort Lauderdale, Florida 33316	1	Department of the Geophysical Sciences
University of Chicago
Chicago, Illinois 60637
1	Director
Ocean Research Institute
University of Tokyo
Tokyo, Japan	1	Coastal Engineering Laboratory
University of Florida
Gainesville, Florida 32601
1	Marine Biological Association
of the United Kingdom
The Laboratory
Citadel Hill
Plymouth, England	1	Institute of Geophysics
University of Hawaii
Honolulu, Hawaii 96825
1	Geology Department
University of Illinois Library
Urbana, Illinois 61501	1	Mr. J. A. Gast
Wildlife Building
Humboldt State College
Arcata, California 95521
		1	Department of Geology & Geophysics
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

<p>Woods Hole Oceanographic Institution Reference No. 68-34</p> <p>CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM by Jonathan Leiby. 10 pages. May 1968. Contract N00014-66-C0241 NR 083-004.</p> <p>The general lack of attention given to handling large and heavy weights from oceanographic ships in a sea way has been pointed out with the advent of small submersibles. With the acquisition and operation of the deep submergence research submarine ALVIN at Woods Hole, this lack of a successful system has become an acute problem. The funding for design and construction of a new research ship (AGOR-15), to be furnished to Woods Hole by the Navy, has provided the opportunity to survey the state of the art and to develop an improved system for handling ALVIN. A review of the various systems used in handling existing submersibles is given, and the detail performance specifications are given. The requirements for the system include constant tension pick-up and launching, automatic hook-up and release, and control of the motion and swing of the submersible during the hoisting operation. The design and engineering methods being used to produce this system which is now under construction, are given in detail.</p>	<ol style="list-style-type: none"> 1. Submersible Handling System 2. Research Submersibles Handling 3. Oceanographic Submersibles <ol style="list-style-type: none"> I. Leiby, Jonathan II. N00014-66-C0241 NR 083-004 <p>This card is UNCLASSIFIED</p>
---	--

<p>Woods Hole Oceanographic Institution Reference No. 68-34</p> <p>CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM by Jonathan Leiby. 10 pages. May 1968. Contract N00014-66-C0241 NR 083-004.</p> <p>The general lack of attention given to handling large and heavy weights from oceanographic ships in a sea way has been pointed out with the advent of small submersibles. With the acquisition and operation of the deep submergence research submarine ALVIN at Woods Hole, this lack of a successful system has become an acute problem. The funding for design and construction of a new research ship (AGOR-15), to be furnished to Woods Hole by the Navy, has provided the opportunity to survey the state of the art and to develop an improved system for handling ALVIN. A review of the various systems used in handling existing submersibles is given, and the detail performance specifications are given. The requirements for the system include constant tension pick-up and launching, automatic hook-up and release, and control of the motion and swing of the submersible during the hoisting operation. The design and engineering methods being used to produce this system which is now under construction, are given in detail.</p>	<ol style="list-style-type: none"> 1. Submersible Handling System 2. Research Submersibles Handling 3. Oceanographic Submersibles <ol style="list-style-type: none"> I. Leiby, Jonathan II. N00014-66-C0241 NR 083-004 <p>This card is UNCLASSIFIED</p>
---	--

<p>Woods Hole Oceanographic Institution Reference No. 68-34</p> <p>CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM by Jonathan Leiby. 10 pages. May 1968. Contract N00014-66-C0241 NR 083-004.</p> <p>The general lack of attention given to handling large and heavy weights from oceanographic ships in a sea way has been pointed out with the advent of small submersibles. With the acquisition and operation of the deep submergence research submarine ALVIN at Woods Hole, this lack of a successful system has become an acute problem. The funding for design and construction of a new research ship (AGOR-15), to be furnished to Woods Hole by the Navy, has provided the opportunity to survey the state of the art and to develop an improved system for handling ALVIN. A review of the various systems used in handling existing submersibles is given, and the detail performance specifications are given. The requirements for the system include constant tension pick-up and launching, automatic hook-up and release, and control of the motion and swing of the submersible during the hoisting operation. The design and engineering methods being used to produce this system which is now under construction, are given in detail.</p>	<ol style="list-style-type: none"> 1. Submersible Handling System 2. Research Submersibles Handling 3. Oceanographic Submersibles <ol style="list-style-type: none"> I. Leiby, Jonathan II. N00014-66-C0241 NR 083-004 <p>This card is UNCLASSIFIED</p>
---	--

<p>Woods Hole Oceanographic Institution Reference No. 68-34</p> <p>CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM by Jonathan Leiby. 10 pages. May 1968. Contract N00014-66-C0241 NR 083-004.</p> <p>The general lack of attention given to handling large and heavy weights from oceanographic ships in a sea way has been pointed out with the advent of small submersibles. With the acquisition and operation of the deep submergence research submarine ALVIN at Woods Hole, this lack of a successful system has become an acute problem. The funding for design and construction of a new research ship (AGOR-15), to be furnished to Woods Hole by the Navy, has provided the opportunity to survey the state of the art and to develop an improved system for handling ALVIN. A review of the various systems used in handling existing submersibles is given, and the detail performance specifications are given. The requirements for the system include constant tension pick-up and launching, automatic hook-up and release, and control of the motion and swing of the submersible during the hoisting operation. The design and engineering methods being used to produce this system which is now under construction, are given in detail.</p>	<ol style="list-style-type: none"> 1. Submersible Handling System 2. Research Submersibles Handling 3. Oceanographic Submersibles <ol style="list-style-type: none"> I. Leiby, Jonathan II. N00014-66-C0241 NR 083-004 <p>This card is UNCLASSIFIED</p>
---	--

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Woods Hole Oceanographic Institution Woods Hole, Massachusetts		2a. REPORT SECURITY CLASSIFICATION Unclassified	
		2b. GROUP	
3. REPORT TITLE CONSTANT TENSION SUBMERSIBLES HANDLING SYSTEM			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Technical Report			
5. AUTHOR(S) (Last name, first name, initial) Leiby, Jonathan			
6. REPORT DATE May 1968		7a. TOTAL NO. OF PAGES 10	7b. NO. OF REFS 7
8a. CONTRACT OR GRANT NO. N00014-66-C0241 NR 083-004		9a. ORIGINATOR'S REPORT NUMBER(S) WHOI Reference No. 68-34	
b. PROJECT NO.		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.			
d.			
10. AVAILABILITY/LIMITATION NOTICES This document has been approved for public release and sale; its distribution is unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY Office of Naval Research Washington, D.C.	
13. ABSTRACT <p>The general lack of attention given to handling large and heavy weights from oceanographic ships in a sea way has been pointed out with the advent of small submersibles. With the acquisition and operation of the deep submergence research submarine ALVIN at Woods Hole, this lack of a successful system has become an acute problem. The funding for design and construction of a new research ship (AGOR-15), to be furnished to Woods Hole by the Navy, has provided the opportunity to survey the state of the art and to develop an improved system for handling ALVIN. A review of the various systems used in handling existing submersibles is given, and the detail performance specifications are given. The requirements for the system include constant tension pick-up and launching, automatic hook-up and release, and control of the motion and swing of the submersible during the hoisting operation. The design and engineering methods being used to produce this system which is now under construction, are given in detail.</p>			

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
1. Submersible Handling System						
2. Research Submersibles Handling						
3. Oceanographic Submersibles						

INSTRUCTIONS

1. **ORIGINATING ACTIVITY:** Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.

2a. **REPORT SECURITY CLASSIFICATION:** Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. **GROUP:** Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. **REPORT TITLE:** Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. **DESCRIPTIVE NOTES:** If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. **AUTHOR(S):** Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. **REPORT DATE:** Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. **TOTAL NUMBER OF PAGES:** The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. **NUMBER OF REFERENCES:** Enter the total number of references cited in the report.

8a. **CONTRACT OR GRANT NUMBER:** If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. **PROJECT NUMBER:** Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. **ORIGINATOR'S REPORT NUMBER(S):** Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. **OTHER REPORT NUMBER(S):** If the report has been assigned any other report numbers (*either by the originator or by the sponsor*), also enter this number(s).

10. **AVAILABILITY/LIMITATION NOTICES:** Enter any limitations on further dissemination of the report, other than those

imposed by security classification, using standard statements such as:

- (1) "Qualified requesters may obtain copies of this report from DDC."
- (2) "Foreign announcement and dissemination of this report by DDC is not authorized."
- (3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."
- (4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."
- (5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. **SUPPLEMENTARY NOTES:** Use for additional explanatory notes.

12. **SPONSORING MILITARY ACTIVITY:** Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.

13. **ABSTRACT:** Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. **KEY WORDS:** Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, roles, and weights is optional.