Appendix B- UNOLS Overboard Handling Systems- Design and Operation Standards

B.0 Introduction

B.0.1 Objective and Approach

The objective of this appendix is ensuring the safety of personnel and the integrity of equipment in the practice of deploying oceanographic instrumentation with overboard handling systems from research vessels. The standards and procedures in Appendix B complement the rope and cable safe working standards contained in Appendix A.

B.0.2 Acronyms

- ABL Assigned Breaking Load
- CFR U.S. Code of Federal Regulations
- DLT Design Line Tension
- EMT Estimated Maximum Tension
- FS Factor of Safety
- MCD Maximum Capability Document
- NAME Naval Architecture and Marine Engineering
- NBL Nominal Breaking Load
- OHS Overboard Handling System
- RVSS Research Vessel Safety Standards
- SWL Safe Working Load
- SWT Safe Working Tension
- UDT Ultimate Design Tension
- UNOLS University-National Oceanographic Laboratory System
- USCG United States Coast Guard

B.0.3 Definitions-

Component	Any part of an Overboard Handling System (e.g. winch, tension member, hydraulic pump, deck bolt).
Design Line Tension (DLT)	The greatest tension an OHS or component is designed to withstand.
Factor of Safety (FS)	For components: FS = S_{fail} / S_{calc}, where S_{fail} is the stress at which a component yields or otherwise begins to fail, and S_{calc} is the greatest calculated stress in a component when submitted to a line tension (e.g., UDT, DLT or SWT). FS differs for tension members: See Appendix A.
Fixed System	A complete or partial Overboard Handling System installed on a vessel.
Inspected Vessel	A vessel that is inspected and certificated by USCG as required by 46 CFR subchapter U.
Load Geometry	The range of directions that a tension member might enter into or depart from a component.
Maximum Capability Document (MCD)	A document that defines a component's or system's safe working tension (SWT).
Nominal Breaking Load	Defined in Appendix A: manufacturer's minimum published breaking load for a tension member
Overboard Handling System (OHS)	A system used to tow objects, to lower them beneath the surface of the water, or to retrieve them from beneath the surface of the water. A system is only considered an OHS if it features a tension member coupling the object and vessel, and payed beneath the surface of the water.
Safe Working Tension (SWT)	The greatest line tension that may be placed on an OHS or component under normal operating conditions. SWT differs for tension members: see Appendix A.
Wet Weight Handling Gear	Gear used to lower equipment, apparatus or objects beneath the surface of the water or for trailing objects, where the wire rope or cable is payed out beneath the surface and becomes part of the line pull at the head sheave or winch drum. Wet weight handling gear may constitute an OHS or be an OHS component.

B.1 Basis and Scope of Application

The design and operation standards in this appendix are based on the requirements of the United States Code of Federal Regulations, 46 CFR Subpart 189.35 - Weight Handling Gear installed on oceanographic vessels. 46 CFR 189.35 legally applies only to U.S. inspected vessels. However, it is UNOLS policy that the standards in this appendix are applicable to overboard handling systems in all UNOLS vessels.

Although based on the requirements of 46 CFR 189, Appendix B does not replace nor supersede applicable federal and/or classification society regulations or standards.

The requirements of this Appendix shall apply to all wet weight handling gear installed on oceanographic research vessels except weight handling gear designated to handle primary lifesaving equipment or manned submersibles. For the purposes of the RVSS, items of *wet weight handling gear,* as the term is used in 46 CFR 189.35, are considered sub-systems or components of overboard handling systems.

Weight handling gear placed under the inspection and testing required for cargo gear by the classification society or cargo gear bureaus may be considered as having met the intent of this subpart.

Wet weight handling gear shall be considered gear used to lower equipment, apparatus or objects beneath the surface of the water or for trailing objects, where the wire rope or cable is payed out beneath the surface and becomes part of the line pull at the head sheave or winch drum. When the ship's crane is utilized in the deployment of gear over the side, at the point when the instrumentation is lowered beneath the surface of the water, then the ship's crane is considered a piece of wet weight handling gear.

Appendix B applies to all overboard handling systems (OHS), both new and existing, used onboard UNOLS vessels including:

- Both fixed and portable systems.
- Each and every component of the overboard handling system. (From the deck bolts, winch foundations and winches, to the shackles, sheaves, rollers, fairleads, A-frames and the entire wire train including all shipboard structures that serve as attachment points).
- Cranes that are used to deploy any science package below the sea surface.

B.2 Overboard Handling System Design

Systems should incorporate the following minimum design criteria:

- System components shall be designed, as a minimum, to withstand and operate in excess of the Design Line Tension (DLT).
    - For inspected vessels the DLT is defined as the Nominal Breaking Load (NBL) of the strongest tension member used.
    - For uninspected vessels the DLT is defined as either the NBL of the tension member or the maximum tension when a load limiting device is used.

- The factor of safety for all metal structural parts shall be a minimum of 1.5 (i.e., the yield strength of the material shall be at least 1.5 times the calculated stresses resulting from application of a load equal to the DLT).
- Suitable assumptions for the actual loading conditions shall be used in the design of wet weight handling gear. The lead of the wire rope from the head sheave or winch drum shall be considered to vary from the vertical and in azimuth in a manner to represent the most adverse loading condition.

B.2.1 Load Limiting Devices are designed to prevent a load exceeding the DLT autonomously.

B.2.1.1 Weak links shall be acceptable for use when the setting prevents the tension at the head sheave from exceeding the DLT. Weak links shall be of a calibrated design.

B.2.1.2 Auto-Render is a setting causing a winch to pay out in order to prevent the DLT from being exceeded. The winch shall not free spool but rather automatically pay out, in a controlled fashion, then resume its previous operating state.

B.2.1.3 Torque Limiters are devices that limit that maximum torque applied to a drum and are calibrated. This is limited to devices designed to operate in this manner without damage, wear is acceptable (IE brake pads). Further, devices shall not allow free spooling and automatically reset to operable state after an over torque event. Acceptable devices include: torque limiting couplers with automatic reset, relief valves, brake slipping, and electronic motor torque control.

B.2.1.4 Heave compensators, wire cutters, and non-autonomous devices are not load limiting devices.

B.2.2 Recommended Design Features The following items are recommended and should be considered for the design of new equipment and retrofitted to existing equipment as deemed necessary by risk assessment.

B.2.2.1 Guards should be installed to prevent personnel injuries from rotating equipment, pinch points, and other hazards.

B.2.2.2 Signaling Devices are ideally installed and setup to warn personnel of unexpected equipment startup especially when it operates automatically or is operated remotely.

B.2.2.3 Accessible E-Stops should be placed at all operator stations as well as locally to the equipment based on risk assessment.

B.2.2.4 Electrical Safe Guards should be in place to accommodate lock out/tag out procedures as well as either a fused disconnect or circuit breaker.

B.2.2.5 Manual Operating Devices are recommended to require constant operator intervention. Dead man style controls, (i.e. spring centered joysticks, no friction locks), interlocks (mechanical or electrical), are recommended to prevent inadvertent operation.

B.2.2.6 Maximum Capability Documents (MCD) should be produced for new equipment when it is acquired.

B.3 Installation, Initial Testing and Labelling

B.3.1 Installation All components of an OHS must be properly installed in accordance with the manufacturer's requirements. In addition:

- Suitable safety guards must be installed around rotating machinery, hazardous cable runs and at other appropriate locations.
- Operating limitations must be posted in an appropriate manner.
- The installation must not violate the approved trim and stability limitations of the vessel.

B.3.2 Initial Testing An installation load test and safety assessment shall be conducted by the owner, ship's master and the equipment operator. For inspected vessels, it is the responsibility of the owner or operator to notify the Coast Guard Officer in Charge-Marine Inspection, of the time and place of the installation tests when occurring in a port of the United States to permit a marine inspector to witness the tests if desired. For uninspected vessels the owner or operator shall make every effort to meet the requirements of an inspected vessel for installation load tests. Subsequent owner or operator conducted tests may be required at the time of the vessel's inspection periods if a visual examination or review of the equipment record reveals evidence of an unsafe condition.

Tests should normally consist of exercising the equipment as a unit with a proof load 25 percent in excess of the equipment's normal working load; however, manufacturer's design limitations should not be exceeded. Consideration shall be given to the plans of loading when conducting these tests. Braking, safety and limiting devices shall be tested whenever feasible.

Safety assessment examinations of weight handling gear will normally consist of a visual examination with access covers removed. Suitability of the equipment for the service intended will be emphasized. Disassembly of the equipment will be required only when there is evidence of a deficiency or an unsafe condition. Non-destructive tests, such as radiography, ultrasonic, electronic, or other methods may be used if appropriate, but are not required.

B.3.2.1 Standard Deck Hardware such as deck bolts, shackles, swivels, and cleats do not normally require initial testing provided they are deemed acceptable via manufacturer's data sheets or manufacturer's proof loading.

B.3.3 Labelling OHS components must be labelled with SWT, most recent test date, and whenever possible, a SWT diagram providing a clear illustration of the tension member's allowable range of angles when loaded to SWT. For deck hardware including deck bolts, and shackles, manufacturer's markings indicating the grade of bolt or load rating for that component will satisfy the labelling requirement.

B.4 Routine OHS Testing

B.4.1 General Requirements Test loads must be measured with a calibrated instrument, or by using a certified test weight. Test loads may not exceed the SWT of the test rig. The component being tested must be loaded to 125% of the applicable SWT. Tests must be conducted in a manner that most closely mimics the use of a system or component at sea.

B.4.2 Requirements for Fixed OHS In accordance with international standards, after installation an OHS must be tested at least once every five years, and after major repairs or modifications to the system.

B.4.3 Requirements for Portable Systems An OHS that is entirely portable, or is formed by combining both fixed and portable components, shall only be used on a vessel if it has been tested in a configuration(s) that mimics or exceeds that in which it will be used, in the previous five years. This can be done piecewise or in an assembled fashion. Operational testing is required for every installation.

B.4.4 Requirements for Components If the test loads for a general-purpose component are effectively applied during the course of an OHS test, then the OHS test satisfies the component testing requirements.

B.4.4.1 Deck Sockets and Foundations These components need only be load tested if they are used as part of an OHS.

B.4.4.2 Tension Members Testing must be done in accordance with Appendix A of the RVSS.

B.4.4.3 Portable Components For components that are not part of a fixed or self-contained portable OHS, i.e., portable winches and sheaves, shall be tested independently in a manner simulating component use.

B.4.4.4 Standard Deck Hardware such as deck bolts, shackles, swivels and cleats must be maintained in good condition. The manufacturer's markings indicating the grade of bolt or load rating will serve the requirement of identifying the safe working tension load. Hardware damaged or loaded beyond its safe working tension/load must be immediately marked as "not for use" and disposed of.

B.4.4.5 Deck Sockets that are damaged must be prominently marked to prevent inadvertent use.

B.4.5 Test Logs must encompass every OHS and component, and contain at a minimum:

- A test date for each entry.
- The test method and names of personnel accomplishing it.
- Sufficient information to determine the test date for each piece of standard deck hardware (e.g., deck bolts, shackles, swivels and cleats).
- Entries whenever an OHS or component is inspected, repaired, or experiences a casualty.

All test logs must be made available to representatives of regulatory agencies and UNOLS inspection teams.

B.5 Documentation

B.5.1 Plans

Plans should be normally available for each fixed OHS, portable OHS, and components on a vessel, including:

- One line electrical diagrams showing appropriate overload protection as currently required by subchapter J (Electrical Engineering) of 46 CFR 189.35.
- Plans showing hydraulic or pneumatic equipment.
- Stress and/or arrangement diagrams with supporting design calculations as appropriate to the specific equipment in question.

For inspected vessels, submission of plans or other technical information may be required by the Coast Guard Officer in Charge-Marine Inspection.

B.5.2 Equipment Records must include test logs as described in section B.4.5 of this Appendix. Records including entries for inspections, important repairs, and casualties are required for fixed systems and recommended for portable systems and components.

B.5.3 OHS Operator's Manuals An OHS Operator's Manual must be maintained for each OHS (except for those combining portable and fixed equipment). Each Operator's Manual must contain at a minimum:

- A detailed description of the OHS layout, including:
    - The location of each major component.
    - The orientation of each major component in each OHS configuration.
    - The geometry of the tension member in each OHS configuration.
    - The overall dimensions of each major component.
    - The weight of major portable components.
    - System particulars (i.e. operating order or considerations, not duplicating component manuals. Example: Turn on A-Frame HPU then Winch HPU, or operate equipment synchronized as described in A-Frame manual and Winch Manual).
- OHS test procedures.
- Procedural safety requirements.
- Operator training procedures.
- References to individual component manuals or data sheets as applicable.
- Routine maintenance procedures should be documented or referenced.

B.5.4 Training Records As indicated in section B.6, records of initial operator training and annual competency checks must be maintained and made available for UNOLS inspections.

B.5.5 Test Logs must be maintained in accordance with B.4.5.

B.5.6 Other Optional System Documentation

Vessels and operating institutions are encouraged to maintain any other documentation, such as manufacturer's manuals and information, that may be useful over the service life of the OHS or component. This information should be readily available for shipboard operators and repair personnel.

Maximum Capability Documents (MCDs) may be available for many systems and components. MCDs provide detailed technical information that can enhance safe operation. The MCD generally specifies the design line tension (DLT) and safe working tension (SWT) of an OHS or component, and generally includes a description of the reaction forces the OHS or component will produce. Manufacturers' data sheets may serve as MCDs for standard deck hardware, such as shackles and swivels, and for tension members.

B.6 OHS Training

Personnel who will operate OHS must receive training and be able to demonstrate competency in operating equipment and knowledge of safety procedures. A training program must be developed for each operating station, appropriate to the complexity of the OHS or component, and include the system operator's manual, monitoring guidelines, and Appendix A requirements as applicable. Training should be conducted in hands-on fashion whenever possible.

Operator training programs shall require an annual demonstration of competence, and must include auditable records of initial training and competency checks.

B.7 Responsibilities

B.7.1 UNOLS Operating Institution and Marine Superintendent

The Marine Superintendent, acting on behalf of the UNOLS Operating Institution and the owning agency or institution, is responsible for ensuring overall compliance with the provisions of Appendix B as it pertains to overboard handling systems and wet weight handling components.

When purchasing a new OHS or major component, the Marine Superintendent must work with the manufacturer, and UNOLS technicians or other subject matter experts, to ensure that all potential uses, deployment modes and system configurations are identified. The Marine Superintendent must ensure installation, system testing and sea trials are supervised by a qualified person, and approve the manufacturer's training program for the equipment

B.7.2 Research Vessel Master The master of the vessel shall ensure:

- Onboard OHS and components are properly installed, secure for sea and do not violate approved trim and stability information.

- Suitable safety guards are installed.
- Operating limitations are posted in an appropriate manner.
- Only qualified operators are permitted to operate OHS, training is documented, and qualified operators are designated by the master of the vessel in writing.
- When gear is being operated, the minimum number of necessary persons are in the immediate area, and comply with all safety requirements.
- Equipment and records are maintained on the equipment as indicated in section B.5.2.
- Prior to a vessel's departure, an entry is made in the official logbook that the ship's weight handling gear is in compliance with the applicable requirements.

B.7.3 Science Party The Principal Investigator shall:

- Consult with the Marine Superintendent and vessel personnel, as appropriate, to determine planned use of OHS equipment. Expected maximum tension, dimensions, and weight of equipment to be deployed with ship's equipment must be provided. The written cruise plan but must include sufficient detail to determine that onboard equipment can be safely used for planned operations at sea. The Overboard Handling Data Document (Figure B-1) should be used for complex or high-tension operations.
- Ensure science party-provided handling systems have been tested in accordance with section B.4 of this Appendix, or make suitable arrangements to test the OHS aboard the vessel prior to departure from port.Ensure science party personnel are briefed on safety requirements and emergency procedures prior to beginning OHS operations

Figure B.1: Overboard Handling Data Document (see section B.7.3)

Primary Deployment Information:	Science Party Response
Deployment Type	
Provide a brief narrative of scientific purpose and the equipment to be deployed. Attach drawings or other documents as required to describe the nature of deployment and the OHS or other equipment used/needed to carry it out.	
Package Type	
Maximum Package Weight (in water) (lbf)	
Maximum Package Mass (weight in air) (lbm)	
Added Weight (in water) (lbf)	
Added Mass (weight in air) (lbm)	
Maximum Drag (lbf)	
Maximum Extraction Force (lbf)	
Maximum Anticipated Tension Member Deployment Length (m)	
Deployment Depth (m) / Water Depth (m) / Percent of tension member deployed length to water depth	
OHS/Components Furnished by Science Party	
Vessel Services Required	
Tension Member Type	
Maximum Tension Member Weight (in water) (lbf)	
Maximum Tension Member Mass (weight in air) (lbm)	
Tension Member ABL/SWT@FS (lbf)	

Load Mitigating Devices	