

## Appendix B

# UNOLS Overboard Handling Systems Design Standards and Criteria for the Design and Operation of Overboard Handling Systems

### B.0. Introduction

#### B.0.1. Objective

Appendix B provides a unified code of practice for the design and operation of overboard handling systems used onboard vessels in the UNOLS Fleet. It is not intended to supersede existing regulations. It is intended only to better define acceptable design limits, procedures, documentation, and capabilities for overboard handling systems used specifically for modern oceanographic research.

#### B.0.2. Acronyms

- ABL Assigned Breaking Load
- CFR Code of Federal Regulations
- CTD Conductivity, Temperature and Depth
- DLT Design Line Tension
- DP Dynamic Positioning
- EMT Estimated Maximum Tension
- FS Factor of Safety
- MCD Maximum Capability Document
- NAME Naval Architecture and Marine Engineering
- NBL Nominal Breaking Load
- NSF National Science Foundation
- OHDD Overboard Handling Data Document
- OHS Overboard Handling System
- RVSS Research Vessel Safety Standards
- SWT Safe Working Tension
- UDT Ultimate Design Tension
- UNOLS University-National Oceanographic Laboratory System
- USCG United States Coast Guard



### **B.0.3. Definitions**

<b>B.0.3.1. Assigned Breaking Load (ABL)</b>	Defined in Appendix A: The lesser of the nominal breaking load (NBL) and the tested breaking load (TBL).
<b>B.0.3.2. Added Mass</b>	The anticipated mass of sampled or entrained material that will be added to the science package or tension member during the course of a deployment.
<b>B.0.3.3. Added Weight</b>	The anticipated weight of sampled or entrained material that will be added to the science package during the course of a deployment.
<b>B.0.3.4. Auto Render</b>	A winch's ability to automatically pay out at a pre-set maximum tension in order to prevent this tension from being exceeded.
<b>B.0.3.5. Coaming</b>	A vertical surface designed to prevent water from entering a vessel; it most commonly refers to the raised plating surrounding a hatch or other opening.
<b>B.0.3.6. Component</b>	Any part of an OHS (e.g. winch, tension member, hydraulic pump, deck bolt).
<b>B.0.3.7. Design Line Tension (DLT)</b>	The greatest line tension an OHS/component is designed to withstand. DLT is further defined in §§ B.4.5 - B.4.7
<b>B.0.3.8. Downflooding</b>	The flooding of a compartment due to water on deck.
<b>B.0.3.9. Drag</b>	A force that arises when fluid flows around a component. It opposes efforts to move the component through the fluid.
<b>B.0.3.10. Estimated Maximum Tension (EMT)</b>	Defined in Appendix A: An estimate of the greatest line tension that will occur during a given deployment. It's calculated using specific properties of the OHS, the science package, and other factors.
<b>B.0.3.11. Factor of Safety (FS)</b>	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.
<b>B.0.3.12. Fixed System</b>	A complete or partial OHS permanently installed on a vessel.
<b>B.0.3.13. Inspected Vessel</b>	A vessel that is inspected and certificated by USCG as required by 46 CFR subchapter U.

<b>B.0.3.14. Load Geometry</b>	The range of directions that a tension member might enter into or depart from a component.
<b>B.0.3.15. Maximum Capability Document (MCD)</b>	A document that defines a component/system's safe working tension (SWT). More detailed information about the MCD is given in § B.5
<b>B.0.3.16. Maximum Drag</b>	The greatest anticipated amount of drag that will be imparted upon the package and tension member during the course of a deployment.
<b>B.0.3.17. Maximum Package Mass</b>	The greatest anticipated mass of a science package.
<b>B.0.3.18. Maximum Package Weight</b>	The greatest anticipated weight of a science package in water.
<b>B.0.3.19. Maximum Pull Out Load</b>	The greatest anticipated amount of force that will be required to dislodge an item from the sea floor.
<b>B.0.3.20. Maximum Tension Member Mass</b>	The greatest anticipated mass of a tension member.
<b>B.0.3.21. Maximum Tension Member Weight</b>	The greatest anticipated weight of a tension member in water.
<b>B.0.3.22. Nominal Breaking Load (NBL)</b>	Defined in Appendix A: Manufacturer's minimum published breaking load for a tension member.
<b>B.0.3.23. Overboard Handling Apparatus</b>	The component of the OHS that launches/retrieves a package directly from the water, or maintains the tension member leading to the water (e.g. a-frame, hydro-boom).
<b>B.0.3.24. Overboard Handling Data Document (OHDD)</b>	A data sheet developed by the science party to communicate deployment requirements to the operator. The OHDD is described in detail in § B.3
<b>B.0.3.25. Overboard Handling System (OHS)</b>	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.

<b>B.0.3.26. Owner</b>	An individual or group that possesses the exclusive right to hold, use, benefit from, transfer, or dispose of property, as well as maintain in good working order.
<b>B.0.3.27. Package</b>	Any object launched into or retrieved from the water by an OHS.
<b>B.0.3.28. Portable System</b>	A complete or partial OHS intended for temporary use onboard vessels.
<b>B.0.3.29. Reactions</b>	Forces that arise between connected components when one of them becomes loaded.
<b>B.0.3.30. Render-and-Recover</b>	A winch's combined ability to auto render, then haul the tension member back when the tension drops to an amount below the pre-set tension. Generally recovery haul back is limited to the point of the initial rendering.
<b>B.0.3.31. Rig</b>	To arrange, set up, or prepare for use.
<b>B.0.3.32. Subject Matter Expert</b>	<p>A person with recognized expertise in the subject under consideration. This may include manufacturers, engineers, naval architects, and others with demonstrable expertise.</p> <p>In general, engineering analysis must be accomplished by an engineer or naval architect whose area of competence includes the thermal and mechanical aspects of marine machinery design; they must possess a bachelor's degree in mechanical engineering, NAME, or an equivalent field of study, and be licensed or exempt from licensure in their locale.</p> <p>Analysis of a vessel's structure may only be undertaken by subject matter experts licensed to perform NAME services in their locale.</p>
<b>B.0.3.33. Safe Working Tension (SWT)</b>	<p>The greatest line tension that may be placed on an OHS/component under normal operating conditions. See § B.4.4.</p> <p>SWT differs for tension members: See Appendix A.</p>
<b>B.0.3.34. Tension Member</b>	A generic name used to describe a rope or cable in service for over the side work.
<b>B.0.3.35. Tension Mitigation Device</b>	Hardware and/or technology employed in the OHS that limits the tension member's load to a pre-set value.
<b>B.0.3.36. Ultimate Design Tension</b>	The line tension at which a component begins to yield or otherwise fail. See § B.4.3

<b>(UDT)</b>	
<b>B.0.3.37. User</b>	A group or individual which uses, but does not own an OHS/component.

#### **B.0.4. Scope of Application**

Appendix B applies to all overboard handling systems (OHS) used onboard UNOLS vessels including:

- Both fixed systems and portable systems
- Both general purpose systems and dedicated OHS
- Every component of an OHS
- Cranes that are used as OHS components
- Shipboard structures that serve as attachment points for an OHS

OHS and components used onboard *inspected* UNOLS vessels must also comply with the requirements in *46 CFR Subchapter U*.

Appendix B does not apply to the design of components or systems used with human occupied vehicles. Guidance for this activity is set forth in the RVSS chapters *Human Occupied Vehicles* and *UNOLS Safety Standards for Human Occupied Vehicles*.

#### **B.0.5. Date of Application for a New OHS / Component**

OHS and components commencing development on or after 07/15/2014 must comply with the requirements of this document.

#### **B.0.6. Date of Application for an Existing OHS / Component**

OHS and components already in existence, or those completed before the applicable date above, are to be brought into compliance with these standards by 07/15/2016.

#### **B.0.7. Responsibility for Application**

All personnel involved in the design, analysis, manufacture, or operation of an OHS have responsibilities outlined here and elaborated on in following sections. The deployment compliance process is illustrated in a flow chart, which is included as Attachment B.1.

##### **B.0.7.1. The Prospective Owner**

When purchasing a new OHS/component, the prospective owner must:

- Work with the manufacturer, or subject matter expert to ensure that all potential uses, deployment types, and configurations are identified
- Ensure the requirements in § B.0.7.7 are contained in the OHS/component specification or purchase agreement
- If applicable, witness, or delegate a party to witness the tests and trials carried out during the first mobilization and sea trial of the OHS/component per § B.7.1
- If they are required by § B.7.1, review the manufacturer's procedures for rigging and un-rigging the OHS/component, and/or for using it to launch and retrieve packages; approve or reject them

- Review the manufacturer's operator training program; and approve or reject it per § B.8 (when applicable)

### **B.0.7.2. The Owner**

The owner of an OHS/component is responsible for ensuring that it complies with Appendix B. To accomplish compliance the owner must:

- Produce the following documents for each OHS/component:
  - An MCD per § B.5
  - Test procedures and test records per § B.6
  - Procedural and general safety requirements per § B.7
  - An operator training program per § B.8 (when applicable)
- Use these documents to assemble:
  - An MCD component booklet for each component per § B.11 (as required)
  - An OHS operators manual for each OHS per § B.12
- Label the OHS or component per § B.9
- Maintain and abide by the documents and label outlined above
- Ensure each OHS/component maintains compliance with the general safety procedures outlined in § B.7.2
- Carry out periodic testing as prescribed in § B.6

An owner who contracts with a subject matter expert to produce an MCD, test procedure, or training program must:

- Work with the subject matter expert to ensure that all potential uses, deployment types, and configurations are identified.
- Ensure the contract, statement of work, or purchase agreement requires the deliverable to conform with §§ B.5, B.6.6.1, or B.8 (whichever applies).
- Review and approve the test procedure or training program per §§ B.6.6.1 or B.8, respectively (when applicable)
- Prior to a deployment, an owner of a portable OHS/component must:
  - Furnish the operator with an MCD for the OHS/component
  - Provide the operator with the calculations used to evaluate the OHS/component, upon request

### **B.0.7.3. The Operator**

The operator of a vessel is the owner of its fixed systems. Operators are also responsible for ensuring that all portable systems used on their vessels comply with Appendix B. To this end, operators must:

- Verify that the capabilities of each portable OHS/component are explained in an MCD per § B.5
- Verify that each portable OHS/component will be used within the limits defined in its MCD

- Prohibit the use of a portable OHS/component that is without an MCD
- Prohibit the use of a portable OHS/component outside the limits defined in its MCD

If an OHS is formed by combining portable and fixed systems, the operator must:

- Produce an MCD for the OHS per § B.5
- Verify that the OHS will be used within the limits defined in the MCD
- Prohibit the use of the OHS outside the limits defined in its MCD
- Produce OHS testing procedures per § B.6 as required
- Make arrangements for all required tests; request user assistance only when required
- Conduct OHS testing in assistance from the user

The vessel operator must confirm that a fixed system is suitable for a given deployment. The operator must determine suitability by verifying:

- The deployment may be carried out within the limits defined in its MCD

If the science package or the configuration of an OHS is changed during the course of a cruise, and the EMT or the load geometry of the new configuration is not within the limits defined in the OHS MCD, the operator must not allow the deployment. If the scientific operation is to occur, the operator must take one or more of the following actions:

- Change components, component locations, or load geometry to increase SWT
- Change component locations to bring them within the geometric limits defined in the OHS MCD
- Modify the scientific package to reduce the EMT (e.g. reduce package weight, reduce entrained mass, reduce hydrodynamic drag)
- Employ a tension mitigation device/system to reduce the EMT (e.g. a weak link, a winch with motion compensation)
- Make structural modifications to the OHS to increase its SWT

In many of the above cases the operator will be required to produce a new MCD for the OHS.

#### **B.0.7.4. The User**

If an OHS is formed by combining portable and fixed systems, the user must:

- At the request of the operator, assist in making arrangements for testing
- Assist the operator in carrying out testing

#### **B.0.7.5. The Science Party**

Prior to a deployment, the science party must:

- Submit a completed OHDD per § B.3, to the operator in advance of each deployment.
- Select the OHDD submission date in consultation with the operator.

#### **B.0.7.6. The Subject Matter Expert**

Producing an MCD for an OHS/component may require the assistance of a subject matter expert. The subject matter expert shall:

- Work with the owner/prospective owner to ensure that all potential uses, deployment types, and configurations are identified
- Consider all uses, deployment types, and configurations when determining the maximum capability of an OHS/component
- Construct the MCD per § B.5
- Share all structural calculations with the owner, UNOLS, and other agencies that provide the owner with support or oversight; when acting as subject matter experts, manufacturers are exempt from sharing calculations revealing proprietary information.

If called upon to produce a test procedure for a component, the subject matter expert must:

- Derive test load application procedures in consultation with the owner
- Prepare the test procedure per § B.6.6.1
- If called upon to produce a training program, the subject matter expert must:
- Prepare the training program per § B.8

#### **B.0.7.7. The Manufacturer**

The manufacturer of a new OHS/component shall:

- Work with the prospective owner to ensure all potential uses, deployment types, and configurations are identified and reasonable
- Provide design and construction that conforms with §§ B.4, B.7.2, B.9, and B.10 (as they apply)
- Develop procedural safety requirements per § B.7.1
- Provide the owner with an MCD component booklet per § B.11, or an OHS operators manual per § B.12 (as they apply), containing at least:
  - An MCD per § B.5
  - Procedural safety requirements per § B.7.1
  - An operator training program per § B.8 (when applicable)

## **B.0.8. References**

**B.0.8.1. UNOLS RVSS Appendix A, UNOLS Rope and Cable Safe Working Load Standards.**

**B.0.8.2. 46 CFR Chapter 1, Subchapter U**

**B.0.8.3. ABS Rules for Building and Classing Underwater Vehicles, Systems, and Hyperbaric Facilities, 2010**

## **B.1. Companion Standard – RVSS Appendix A**

### **B.1.1. Compatibility**

Appendix B is fully compatible with, and must be used in conjunction with UNOLS RVSS Appendix A, UNOLS Rope and Cable Safe Working Load Standards.

### **B.1.2. Application of Appendix A**

Every OHS is presumed to require a tension member to function in each of its configurations. Therefore, the *safe working tension* (SWT) of an OHS must take into account the (SWT) of its tension member.

Appendix A requires the estimated maximum tension (EMT) be calculated for each deployment scenario. For cases where there is no tension monitoring equipment or low resolution tension monitoring, a deployment shall only be conducted if its EMT is no greater than the  $SWT_{OHS}$ . For cases where there is a high resolution tension monitoring system, the deployment must be halted

## **B.2. Deployment Types**

### **B.2.1. Description**

The depth and nature of an oceanographic deployment are concisely defined by its deployment type. Names, characteristics, and examples of each deployment type are summarized on the following page in Table B.2.1. It should be noted that this table uses deployed tension member length in lieu of deployed package depth to insure against settling that might occur due to an inadvertent loss of vessel speed.

**Table B.2.1 Deployment Type**

Deployment Type	Example
<p><b>B.2.1.1. Towing – Surface (floating or shallow tow)</b></p>	<p>towed arrays (e.g., streamers, smart floats) air gun arrays towed sonar fish (e.g., PES, 3.5kHz, EK60)</p>
<p><b>B.2.1.2. Towing - Mid Water (Where the deployed length of the tension member does not exceed 75% of the water depth)</b></p>	<p>fisheries nets (twin and single wire) magnetometers, sonar, towfish (e.g., SeaSoar, TriAxis, MVP) MOCNESS Anchor-last mooring deployments</p>
<p><b>B.2.1.3. Towing - Deep Water (where the deployed length of the tension member is greater than 75% of the water depth with either intentional or high likelihood of bottom contact)</b></p>	<p>deep water fisheries nets (single wire) sonar, multidiscipline deep-towed platforms dredges, bottom trawls, sledges, grapnel/batfish camera sled, SeaSoar, TriAxis</p>
<p><b>B.2.1.4. Station Keeping – Surface (shallow dips with or without dynamic positioning (DP))</b></p>	<p>plankton nets precision echo sounders (PES) hydrophones free-floating buoys autonomous underwater vehicles (AUVs) (e.g. gliders)</p>
<p><b>B.2.1.5. Station Keeping – Mid Water (where the deployed length of the tension member does not</b></p>	<p>acoustic arrays conductivity, temperature, depth (CTD) other water sampling operations</p>

<b>exceed 75% of the water depth, with or without DP)</b>	
<b>B.2.1.6. Station Keeping – Deep Water (where the deployed length of the tension member is greater than 75% of the water depth with either intentional or high likelihood of bottom contact, with or without DP)</b>	<ul style="list-style-type: none"> <li>• remotely operated vehicles (ROVs)</li> <li>• CTD/water sampler operations</li> <li>• elevators</li> <li>• standard wire coring</li> <li>• deep coring (Synthetic Rope)</li> <li>• multicorer</li> <li>• rock drilling</li> <li>• seabed laboratory placement/retrieval</li> <li>• steered bottom samplers (e.g., HyBIS, ARGO)</li> <li>• anchor-first mooring deployments</li> </ul>

### **B.2.2. Application**

Deployment type is a mandatory entry into the OHDD. This helps ensure the deployment requirements of the science party are clearly communicated to the operator. MCDs must also outline allowable deployment types; their inclusion helps ensure OHS/components are used in a manner consistent with their capabilities. Knowledge of the deployment type is required to select design loads and to identify regulations relevant to the design of an OHS/component. For this reason, specifications for a prospective OHS/component must elaborate on the deployment types it must accommodate.

## **B.3. The Overboard Handling Data Document (OHDD)**

### **B.3.1. Description**

The OHDD is a data sheet developed by the science party to communicate deployment requirements to the operator. One OHDD must be completed by the science party and submitted to the operator in advance of each cruise. The submission date should be selected in consultation with the operator.

Table B.3.1 is a sample OHDD including some examples and explanations that may be of use. A blank sample OHDD is also available in Attachment B.2. Some parameters will not apply to every deployment.

**Table B.3.1 Overboard Handling Data Document**

<b>Primary Deployment Information:</b>	<b>Science Party Response</b>
<b>Deployment Type</b>	
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.	<i>e.g., "Obtain water samples and CTD data for CLIVAR." Anticipate the need to deploy a 36-bottle rosette to a depth of 6000m."</i>  <i>The science party must provide MCDs for the OHSs/components they furnish.</i>
Package Type	<i>e.g., "36-bottle CTD rosette"</i>
Maximum Package Weight (in water)(lbf)	<i>Include specifics about the package if it will be furnished by the science party.</i>
Maximum Package Mass (weight in air) (lbm)	<i>e.g., "2,200 lbm"</i>
Added Weight (in water) (lbf)	<i>e.g., the weight of captured or entrained material other than water, such as mud.</i>
Added Mass (weight in air) (lbm)	<i>e.g., the mass of captured or entrained material, including water.</i>
Maximum Drag (lbf)	<i>e.g., "1,300 lbf"</i>
Maximum Extraction Force (lbf)	<i>Include if applicable and known.</i>
Maximum Anticipated Tension Member Deployment Length (m)	<i>e.g., "6000 m"</i>
Deployment Depth (m) / Water Depth (m) / Percent of tension member deployed length to water depth	<i>Required to confirm deployment type. If multiple deployments are to occur, enter the % for the deployment with the greatest ratio of deployed depth and water depth.</i>
OHS/Components Furnished by Science Party	<i>Elaborate on any OHSs/components, including tension members, the science party will furnish.</i>
Vessel Services Required	<i>Outline any vessel services required for the OHS/components the science party will furnish. e.g., electrical power, hydraulic power, or cooling water.</i>
Tension Member Type	<i>Elaborate on the required tension member construction, if known. e.g., "wire rope," "9/16 3X19 wire rope" or "0.322 EM cable."</i>
Maximum Tension Member Weight (in water) (lbf)	<i>Include specifics about the tension member if it will be furnished by the science party.</i>
Maximum Tension Member Mass (weight	<i>Include specifics about the tension member</i>

in air) (lbf)	<i>if it will be furnished by the science party.</i>
Tension Member ABL/SWT@FS (lbf)	<i>Include specifics about the tension member if it will be furnished by the science party.</i>
Load Mitigating Devices	<i>e.g., render-and-recover and/or weak link along with proposed set values. This must be included if the science party will furnish an OHS, component, or package that features such a device.</i>

## **B.4. Structural Design Criteria**

### **B.4.1. General**

OHS and their components should be designed and analyzed in accordance with a USCG-recognized classification society or professional standard; if a criterion in §§ B.4.2 thru B.4.7 is more conservative, it shall supersede that criterion in the chosen standard unless a special case is granted per 46 CFR § 198.35-11 by the USCG MSC (see § B.4.6).

### **B.4.2. Principal, Secondary, and Worst Case Loading Scenarios**

The deployment type(s) and the most adverse loading scenario(s) must be considered when analyzing or designing an OHS/component.

Because it's rare for a single component to comprise an overboard handling system, these loading scenarios should be used to evaluate components, including the science package and that portion of the ship attached to the OHS, as a completely integrated system. Each loading scenario is defined by a line tension and line of action (direction) at the overboarding sheave (if an OHS) or exit sheave (if a component with one), or at another appropriate location.

#### **B.4.2.1. Principal Loads**

Principal loads are those that occur under ideal conditions, and during the principal phase of a deployment.

#### **B.4.2.2. Secondary Loads**

Secondary loads are those that might occur when conditions are other than ideal. These might occur due to a deviation from ideal vessel attitude, vessel heading, vessel position, scientific package position, or any other parameter.

#### **B.4.2.3. Worst-Case Loads**

Worst-case loads are loads unlikely to occur, but quite likely to cause equipment or personnel casualties. Surprise entanglement with a submerged object might, for example, lead to overloading and damage to an OHS. Because of their serious nature, worst-case loads should be defined in consultation with the operator. Load mitigating devices should be identified and used to prevent their occurrence whenever possible.

### **B.4.3. Ultimate Design Tension (UDT)**

The UDT is the line tension at which a component begins to yield, or otherwise fail. When determining the UDT for a fixed component, calculations must encompass, at a

minimum, its foundation and all structural members adjacent to it. When determining the UDT for a portable component, or any component fastened to an adjacent structure via a bolted joint, calculations must include an evaluation of that joint. A component's UDT must be calculated by a subject matter expert.

#### **B.4.4. Safe Working Tension (SWT)**

SWT is the working tension of an OHS/component—the greatest tension that may be placed on an OHS/component under normal operating conditions.

The SWT of a new component must be arrived at via calculation. Calculations must be carried out by a subject matter expert. If the SWT of an existing component is unknown, and it's infeasible to establish its value via calculation, it may be arrived at via load testing in some cases. §§ B.6.11 provides conditions and procedures for establishing a SWT by way of load testing.

The SWT of an OHS must take into consideration the SWT of each of its components, including its tension member. It may be no greater than the least of its component SWTs. Ideally, establishing the SWT of an OHS will only require one to examine the MCD for each of its components. However, if the component MCD's are insufficient, or if the OHS has a complexity that precludes straightforward evaluation, then its SWT should be established via calculation by a subject matter expert.

The SWT of an OHS/component may never exceed its DLT.

#### **B.4.5. Design Line Tension (DLT)**

The design line tension (DLT) is the greatest line tension an OHS/component is designed to withstand. When subjected to the DLT, an OHS/component must remain operable and have a safety factor of at least 1.5 against yielding or any other form of failure. Generally, the DLT of an OHS must be no less than the nominal breaking load (NBL) of its tension member. However, the DLT of an OHS may be less than NBL if:

##### **B.4.5.1.**

The OHS is intended to be used with a deployed tension member length less than 75% of the nominal water depth for any deployment envisioned for that system. In this case DLT may be as low as the greater of:

*DLT = [max. package weight (in water) + max. tension member weight (in water) + added weight (in water)] + [(max. package mass + max. tension member mass + added mass) x 0.75] + max. hydrodynamic drag*

**or**

*DLT = the maximum line tension imparted by the vessel*

##### **B.4.5.2.**

The OHS features a winch designed and operated with auto render or render-and-recover as described in § B.10.2. In this case DLT may be as low as:

*DLT = the pre-set maximum line tension at which the winch will automatically pay out*

### **B.4.5.3.**

The OHS features a calibrated and tested weak link as described in § B.10.3. In this case DLT may be as low as:

*DLT = the line tension at the overboarding sheave when the calibrated weak link fails*

### **B.4.5.4.**

The vessel carrying the OHS cannot develop thrusts and accelerations sufficient to develop a line tension as great as NBL. Calculations must show that the vessel cannot create this tension:

- i. while under power**
- ii. while in a dead ship or inadvertently anchored situation, given a sea state of 5 and a wave height of 4 meters**
- iii. if decelerated from the greatest anticipated speed to a full stop by a science package or tension member that becomes hung up**

Calculations must also demonstrate that the vessel's stability is adequate to sustain the loads and geometries these scenarios present. If this criterion is used, operating conditions shall be limited to a sea state of 5, and a wave height of 4 meters; DLT may be as low as:

*DLT = the greatest line tension calculated for cases B.4.5.4.i thru B.4.5.4.iii.*

### **B.4.5.5.**

A special case is granted per 46 CFR § 198.35-11 by the USCG MSC (see § B.4.6). If the OHS does not meet criteria B.4.5.1 thru B.4.5.4, DLT may be as low as the greater of:

*DLT = [max. package weight (in water) + max. tension member weight (in water) + added weight (in water)] + [(max. package mass + max. tension member mass + added mass) x 0.75] + max. hydrodynamic drag + max. pull out load*

**or**

*DLT = the maximum line tension defined in the USCG recognized standard the OHS is demonstrated to comply with (When applicable. See § B.4.6, paragraph (4).)*

**or**

*DLT = a greater line tension calculated by a subject matter expert*

The DLT of a component should be arrived at via calculation. When determining the DLT for a fixed component, calculations must encompass, at a minimum, its foundation and all structural members adjacent to it. When determining the DLT for a portable

component, or any component fastened to an adjacent structure via a bolted joint, calculations must include an evaluation of that joint. The DLT of an OHS must take into consideration the DLT of each of its components. It may be no greater than the least of its component DLTs.

#### **B.4.6. Additional Requirements for Inspected Vessels**

An OHS used onboard inspected vessels must comply with 46 CFR ch. 1, subch. U wherever its requirements exceed those in the RVSS. §189.35-9 (c)(1) of this regulation, *Wet Weight Handling Gear*, states that an OHS must:

*"...withstand and operate in excess of the breaking strength of the strongest section or wire to be used in any condition of loading. The safety factor of all metal structural parts shall be a minimum of 1.5..."*

This requires the DLT of an OHS to be no less than the nominal breaking load (NBL) of the tension member without exception.

§189.35-11 of this regulation, *Special Cases*, allows these requirements to be relaxed when they defeat the purpose of an OHS. Relaxation is at the discretion of the USCG Commandant; in practice, the matter is addressed by the USCG Marine Safety Center (MSC). Relaxation is generally allowed provided the owner demonstrates that the OHS meets the standards of a USCG recognized classification society. As of the date of this publication, these societies include: the American Bureau of Shipping (ABS), Det Norske Veritas (DNV), Lloyd's Register (LR), Germanischer Lloyd (GL), Bureau Veritas (BV), RINA S.p.A. (RINA) and ClassNK (NKK).

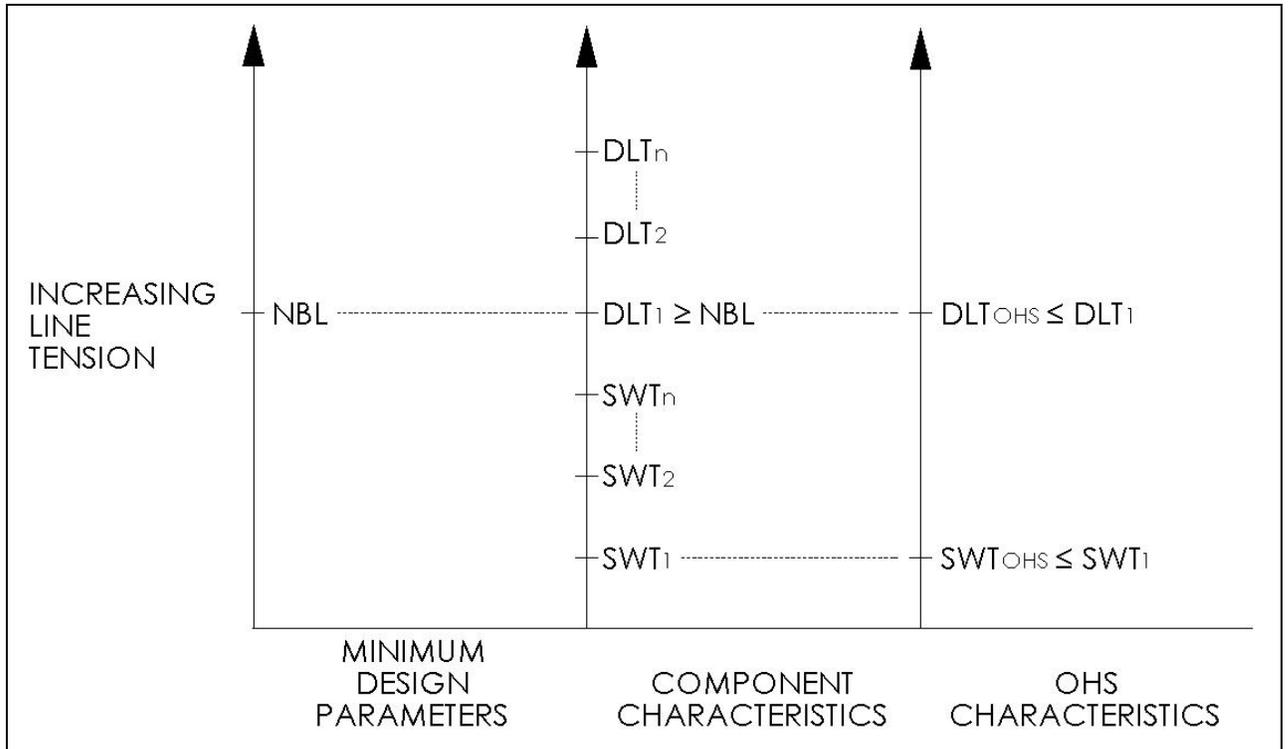
To report a special case under §189.35-11, and request §189.35-9 (c)(1) be relaxed, contact the Commanding Officer (CO) at the USCG Marine Safety Center (MSC).

#### **B.4.7. Acceptable Methods of Constructing and Operating an OHS**

Different OHS constructions require the DLT and SWT of the OHS to be determined in different ways. OHS construction also affects the type of deployment the OHS may be used to carry out, and the type of vessel it may be used on without permission from the USCG MSC.

The sections that follow illustrate allowable OHS constructions. The method of determining the OHS DLT and SWT, and applicable operating parameters are elaborated upon for each construction. Each illustration presumes the OHS consists of an arbitrary number of components, numbered component 1 (weakest), component 2, ..., component n (strongest). SWT<sub>1</sub>, SWT<sub>2</sub>, ..., SWT<sub>n</sub> refer to the SWT of components 1, 2, ..., n, respectively; DLT<sub>1</sub>, DLT<sub>2</sub>, ..., DLT<sub>n</sub> refer to the DLT of OHS components 1, 2, ..., n, respectively.

The DLT for an existing component may be unknown. In this case, the DLT of the OHS cannot be determined. Nonetheless each illustration assumes a component's DLT is known, and both its DLT and SWT take into account the various tension member orientations it might experience as part of the OHS. The DLT and SWT of an OHS are assumed to encompass all tension member orientations required for a given deployment.



**Figure B.4.7.1: Example of an OHS complying with 46 CFR § 189.35-9.**

### **B.4.7.1. Allowable OHS Construction 1**

#### **Key Features**

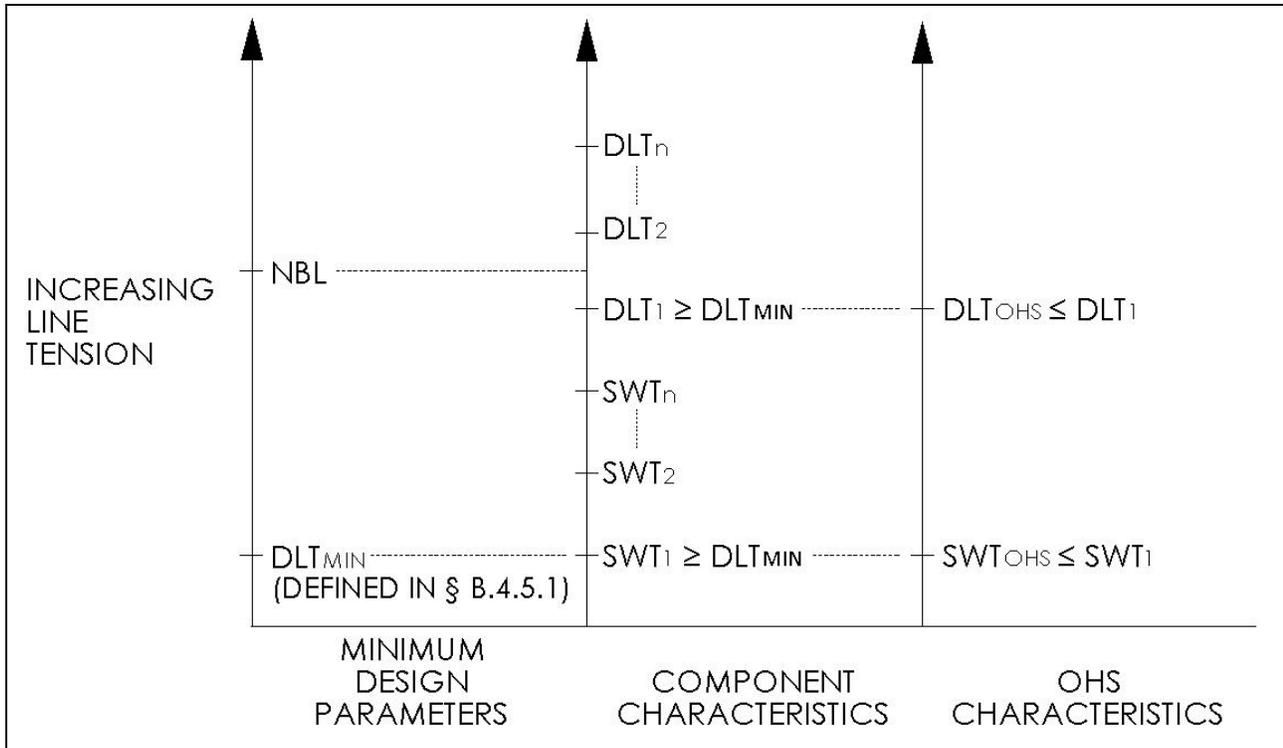
- The DLT of every component is at least as great as the NBL of the tension member.

#### **DLT and SWT**

- The DLT of the OHS ( $DLT_{OHS}$ ) may be no greater than the DLT of the weakest component,  $DLT_1$ .
- The SWT of the OHS ( $SWT_{OHS}$ ) may be no greater than the lowest component SWT,  $SWT_1$ .

#### **Operational Limitations**

- The OHS complies with § B.4.6 and 46 CFR ch. 1, subch. U, § 189.35-9 (c)(1). Therefore, it's acceptable for use on any UNOLS vessel.
- This OHS is acceptable for any deployment provided the EMT for the deployment is no greater than SWT of the OHS.
- Line tension cannot exceed  $SWT_{OHS}$  during normal operations.



**Figure B.4.7.2: Example of an OHS complying with § B.4.5.1**

### **B.4.7.2. Allowable OHS Construction 2**

#### **Key Features**

- The DLT of one or more components is less than the NBL of the tension member.
- The OHS does not feature a load-limiting device.
- The lowest component DLT (DLT<sub>1</sub>) is no less than the minimum DLT (DLT<sub>MIN</sub>) defined in §B.4.5.1.

#### **DLT and SWT**

- The DLT of the OHS (DLT<sub>OHS</sub>) may be no greater than the DLT of the weakest component, DLT<sub>1</sub>.
- The SWT of the OHS (SWT<sub>OHS</sub>) may be no greater than the lowest component SWT, SWT<sub>1</sub>.

#### **Operational Limitations**

- This OHS is acceptable for use on uninspected UNOLS vessels. It may only be used on an inspected UNOLS vessel if a special case is granted by the USCG MSC (see §B.4.6).
- The deployed tension member length must never exceed 75% of the nominal water depth. Therefore, this OHS is restricted to the following deployment types: Towing—Surface (§B.2.1.1), Towing—Mid Water (§B.2.1.2), Station Keeping—Surface (§B.2.1.4), Station Keeping—Mid Water (§B.2.1.5).

- The EMT for each deployment may be no greater than  $SWT_{OHS}$ .
- Line tension cannot exceed  $SWT_{OHS}$  during normal operations.

### B.4.7.3. Allowable OHS Construction 3

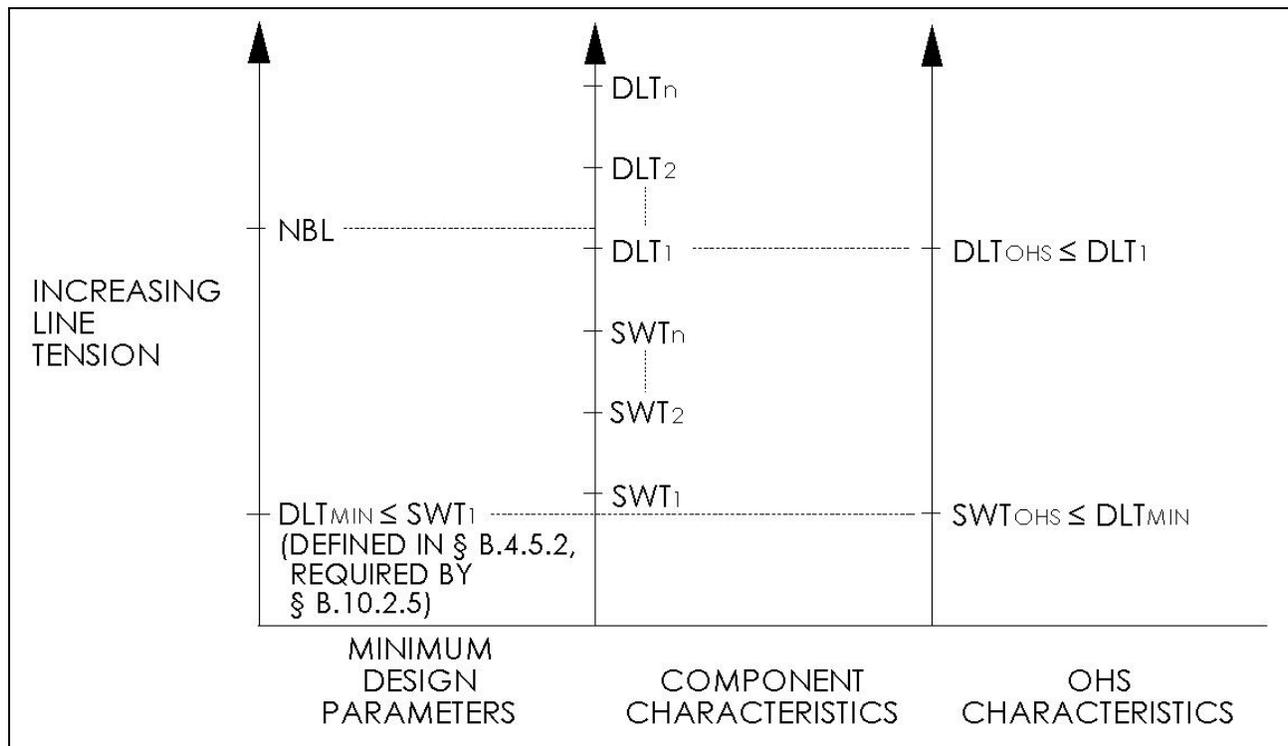


Figure B.4.7.3: Example of an OHS complying with § B.4.5.2

#### Key Features

- The DLT of one or more components is less than the NBL of the tension member.
- The OHS features a winch with auto render or render-and-recover meeting the criterion in §B.10.2.
- The lowest component DLT ( $DLT_1$ ) is no less than the minimum DLT ( $DLT_{MIN}$ ) defined in §B.4.5.2. This will always be true regardless of the value of  $DLT_1$  because  $DLT_{MIN}$  is the winch's rendering tension, §B.10.2.5 requires the rendering tension to be no greater than the lowest component SWT ( $SWT_1$ ), and  $DLT_1$  is, by definition, at least  $SWT_1$ .

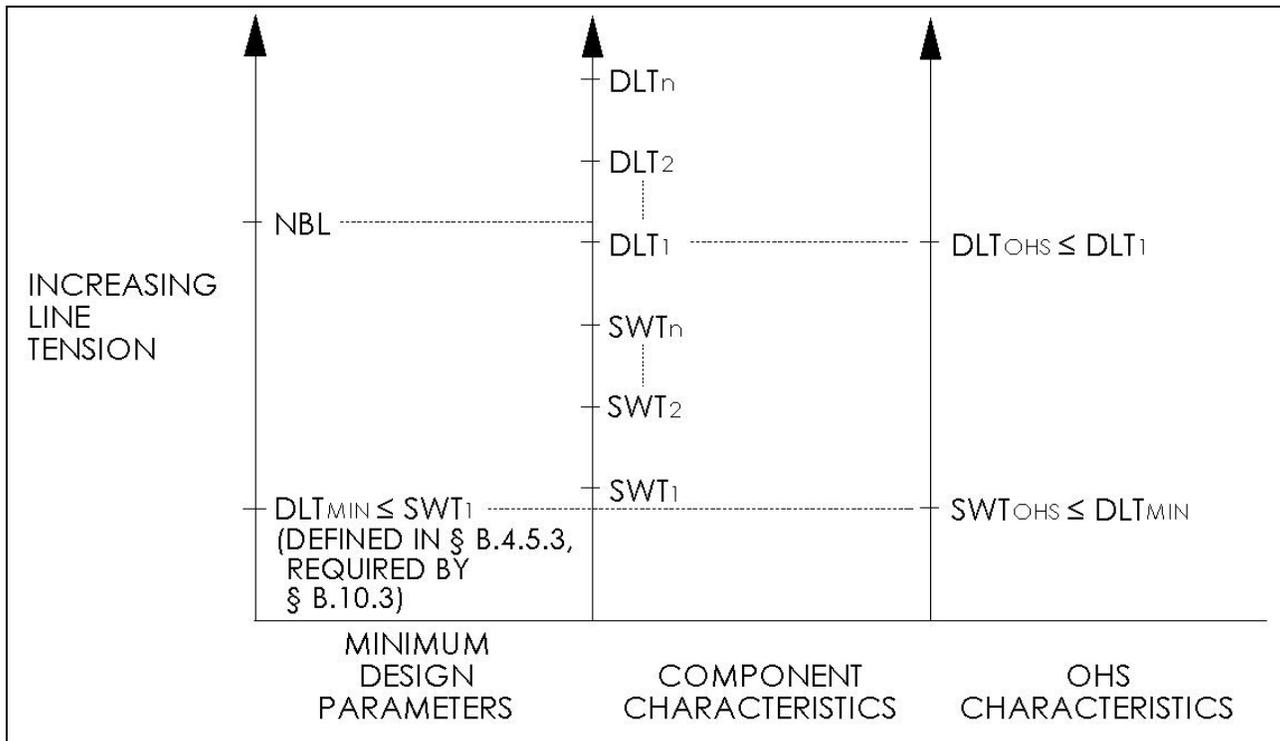
#### DLT and SWT

- The DLT of the OHS ( $DLT_{OHS}$ ) may be no greater than the DLT of the weakest component,  $DLT_1$ .
- The SWT of the OHS ( $SWT_{OHS}$ ) is no greater than the rendering tension,  $DLT_{MIN}$ .

#### Operational Limitations

- This OHS is acceptable for use on uninspected UNOLS vessels. It may only be used on an inspected UNOLS vessel if a special case is granted by the USCG MSC (see §B.4.6).

- This OHS is acceptable for any deployment provided the EMT for the deployment is no greater than  $SWT_{OHS}$ .
- The winch should limit line tension automatically. Nonetheless, the OHS operator must ensure  $SWT_{OHS}$  is not exceeded during normal operations.



**Figure 4.7.4: Example of an OHS complying with § B.4.5.3**

#### **B.4.7.4. Allowable OHS Construction 4**

##### **Key Features**

- The DLT of one or more components is less than the NBL of the tension member.
- The OHS features a weak link installed between the tension member and science package.
- The lowest component DLT (DLT<sub>1</sub>) is no less than the minimum DLT (DLT<sub>MIN</sub>) defined in §B.4.5.3. This will always be true regardless of the value of DLT<sub>1</sub> because DLT<sub>MIN</sub> is the tension at the overboarding sheave when the weak link fails, §B.10.3 requires the weak link to fail before the lowest component SWT (SWT<sub>1</sub>) is exceeded, and DLT<sub>1</sub> is, by definition, at least SWT<sub>1</sub>.

##### **DLT and SWT**

- The DLT of the OHS (DLT<sub>OHS</sub>) may be no greater than the DLT of the weakest component, DLT<sub>1</sub>.
- The SWT of the OHS (SWT<sub>OHS</sub>) may be no greater than the line tension at the overboarding sheave when the weak link fails, DLT<sub>MIN</sub>.

##### **Operational Limitations**

- This OHS is acceptable for use on uninspected UNOLS vessels. It may only be used on an inspected UNOLS vessel if a special case is granted by the USCG MSC (see §B.4.6).
- This OHS is acceptable for any deployment provided the EMT for the deployment is no greater than  $SWT_{OHS}$ .
- The weak link should limit line tension automatically. Nonetheless, the OHS operator must ensure the  $SWT_{OHS}$  is not exceeded during normal operations.

### B.4.7.5. Allowable OHS Construction 5

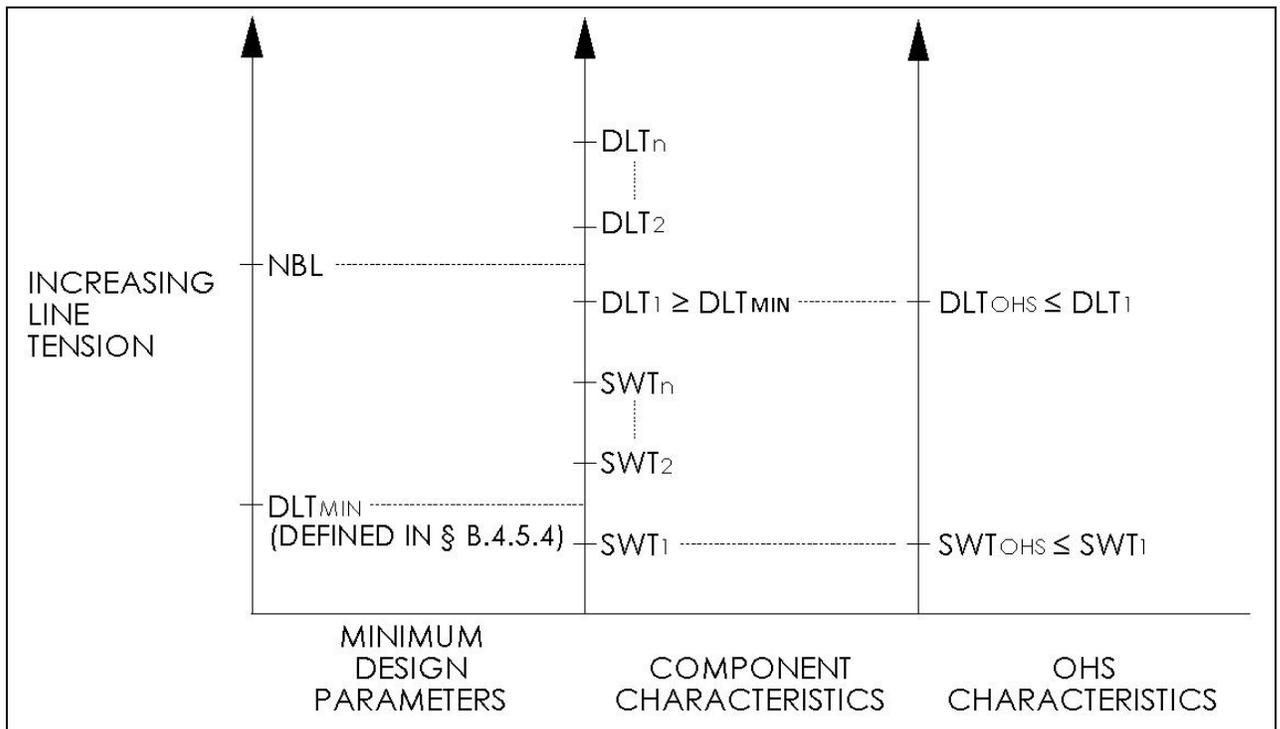


Figure 4.7.5: Example of an OHS complying with § B.4.5.4

#### Key Features

- The DLT of one or more components is less than the NBL of the tension member.
- The OHS does not feature a load-limiting device.
- The lowest component DLT ( $DLT_1$ ) is no less than the minimum DLT defined in §B.4.5.4,  $DLT_{MIN}$ . That is, the DLT of every component is at least as great as any tension the vessel might impart on the OHS.

#### DLT and SWT

- The DLT of the OHS ( $DLT_{OHS}$ ) may be no greater than the DLT of the weakest component,  $DLT_1$ .
- The SWT of the OHS ( $SWT_{OHS}$ ) may be no greater than the lowest component SWT,  $SWT_1$ .

#### Operational Limitations

- This OHS is acceptable for use on uninspected UNOLS vessels. It may only be used on an inspected UNOLS vessel if a special case is granted by the USCG MSC (see § B.4.6).
- The EMT for each deployment may be no greater than the  $SWT_{OHS}$ .
- Line tension cannot exceed the  $SWT_{OHS}$  during normal operations.

#### **B.4.7.6. Allowable OHS Construction 6**

##### **Key Features**

- The DLT of one or more components is less than the NBL of the tension member.
- The OHS does not feature a load-limiting device.
- The lowest component DLT is no less than the minimum DLT defined in §B.4.5.5, DLT<sub>MIN</sub>.

##### **DLT and SWT**

- The DLT of the OHS (DLT<sub>OHS</sub>) may be no greater than the DLT of the weakest component, DLT<sub>1</sub>.
- The SWT of the OHS (SWT<sub>OHS</sub>) may be no greater than the lowest component SWT, SWT<sub>1</sub>.

##### **Operational Limitations**

- This OHS may not be used on any UNOLS vessel unless a special case is granted by the USCG MSC (see § B.4.6).
- The EMT for each deployment may be no greater than the SWT<sub>OHS</sub>.
- Line tension cannot exceed the SWT<sub>OHS</sub> during normal operations.

## **B.5. The Maximum Capability Document (MCD)**

### **B.5.1. Description**

The maximum capability document (MCD) generally specifies the design line tension (DLT) and safe working tension (SWT) of an OHS/component, and generally includes a description of the reaction forces the OHS/component will produce. Excepting deck bolts, every OHS and component, including tension members, must have an MCD. The MCD development process is illustrated in a flow chart, which is included as Attachment B.3.

### **B.5.2. Content**

The MCD for an existing OHS/component must specify its SWT. The MCD for an existing component must also include the reaction forces it places on adjacent structures in terms of SWT.

The MCD for a new OHS/component must specify both its DLT and SWT. The MCD for a new component must also include the reaction forces it places on adjacent structures in terms of DLT.

Components fastening to adjacent structures via a bolted joint must include the reaction forces on the bolts, a diagram of its bolt pattern, and the required bolt strength/grade.

An MCD should identify the standard (s) by which the OHS/component was evaluated. When feasible, the calculations used to evaluate an OHS/component should be attached to its MCD as well.

#### **B.5.2.1. Standard Deck Hardware**

For standard deck hardware, such as a shackle or swivel, a manufacturer's data sheet(s) may serve as an MCD providing the hardware is made to a standard requiring a FS  $\geq 1.5$ , the data sheet(s) identify the standard, and they include the component's SWT.

#### **B.5.2.2. Tension Members**

A manufacturer's data sheet(s) may serve as the basis of a tension member MCD. The MCD must also include a current ABL and a SWT calculated for each applicable FS defined in Appendix A.

#### **B.5.2.3. Custom Components**

A custom component requires a custom MCD.. It must elaborate on the allowable deployment types for the component, include a DLT and/or a SWT for each allowable deployment type, and illustrate the applicable range of tension member geometries.

#### **B.5.2.4. Deck Sockets**

The DLT and SWT of a deck socket will differ depending on its location, the component attached to it, and how the component is rigged. For this reason, a vessel's deck socket MCD must include a DLT and/or a SWT for each unique combination of: component, component rigging, deck socket location, and deck socket pattern. Each

DLT and SWT must be accompanied by a description sufficient to determine its applicability to a given deployment; it should include key component parameters, illustrations of the deck socket pattern, its location on the vessel, the applicable range of tension member geometries, and the allowable deployment type(s).

A deck socket MCD need only encompass those sockets used as OHS components.

#### **B.5.2.5. Winches**

A winch MCD should include information regarding its maximum line pull. It should be sufficient to determine if a package deployed to a given depth may also be retrieved.

#### **B.5.2.6. Tension Mitigation Devices and Systems**

If an OHS/component features a tension mitigation device or system, it's MCD must elaborate on its nature and use. See §§ B.10.2 and B.10.3

#### **B.5.2.7. OHS**

Ideally, examining an MCD for each of its components will be sufficient to produce an OHS MCD. However, if the complexity of the OHS is such that it cannot be evaluated in this way, its MCD must be prepared by a subject matter expert. An OHS MCD must elaborate on allowable deployment types, include a DLT and/or a SWT for each OHS configuration and/or deployment type, and illustrate the applicable range of load geometries.

An OHS MCD must list the component MCDs used in its production, and their version.

### **B.5.3. Application and Responsibilities**

In all but the following two cases, production of the MCD is the sole responsibility of the OHS/component owner. If an MCD does not include the calculations used to evaluate the OHS/component, the owner must furnish them to the vessel operator upon request. When an OHS is formed by combining portable and fixed components, the vessel operator is responsible for producing its MCD. If a portable component is without an MCD, or if the inadequacy of its MCD prevents the OHS from being evaluated, the operator may require the owner to produce a new MCD.

A new OHS/component should be delivered with an MCD component booklet or OHS operators manual (whichever applies) that includes an MCD. The prospective owner should ensure this requirement is clearly stated in the purchase agreement. The MCD component booklet and OHS operators manual are described in §§ B.11 and B.12, respectively.

### **B.5.4. Presentation**

The best method of presenting DLT and SWT will depend on the OHS/component and its use. If it provides sufficient capability in all foreseen configurations, its MCD should present single values for DLT and/or SWT, and illustrate the applicable load geometries. This is the preferred method and the most straightforward. Additional complexity should only be added to the presentation as required to:

- Provide additional capabilities required to carry out all foreseen operations
- Account for load geometries, operations, or configurations that can't be included otherwise

Sample MCDs are included as Attachment B.4 through Attachment B.10. These sample MCDs can be viewed as component MCDs or as the MCDs that make up an OHS System MCD.

## **B.6. Testing and Test Documentation**

### **B.6.1. General Requirements**

Test loads should be measured with a calibrated instrument, as they are applied to an OHS/component. Alternately, the loads may be applied using a certified test weight. Test loads may not exceed the SWT of the test rig, which may include a stand-in tension member.

### **B.6.2. Requirements for Components**

#### **B.6.2.1. Exemptions**

If the test loads for a general purpose component are effectively applied during the course of an OHS test, then the OHS test satisfies that component's testing requirements as well.

If a component is only used as part of a single OHS, and that OHS is tested to 125% of its SWT, as a system, in the configuration that most adversely loads the component, then the component need not be tested individually.

Auxiliary padeyes, such as those found on a-frames and other overboard handling apparatus, need only be tested if they are used as part of an OHS.

Deck sockets that are not used as part of an OHS need not be load tested.

Deck bolts need not be load tested provided they're made to a specification including a minimum strength, and they're marked to indicate their specification or grade. All deck bolts that are not load tested must be inspected periodically.

#### **B.6.2.2. Deck Sockets and Foundations**

Equipment foundations and deck sockets need only be load tested if they are used as part of an OHS.

Deck socket test records must be sufficient to determine the test date for each socket. However, it is not required that each socket have its own test log.

#### **B.6.2.3. Tension Members**

Tension members are to be tested in accordance with UNOLS RVSS Appendix A, UNOLS Rope and Cable Safe Working Load Standards.

#### **B.6.2.4. Other Components**

Unless otherwise stated in the sections that follow, all non-exempt components shall be tested to 125% of their SWT.

#### **B.6.2.5. Frequency**

All components are to be tested at least twice every five years, not to exceed three years between tests, with the following exceptions: auxiliary padeyes, and deck sockets.

An auxiliary padeye or deck socket may be used as part of an OHS if it has received a load test in the previous three years.

All deck bolts that are not load tested must receive biennial inspections.

### **B.6.3. Requirements for Fixed OHS**

An OHS shall be tested once, in each test configuration, at least twice every five years, not to exceed three years between tests. In each test, the OHS must be loaded to 125% of the applicable OHS SWT.

### **B.6.4. 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 on that vessel, in the same configuration(s) it will be used, in the previous three years. In each test, the OHS must be loaded to 125% of the applicable OHS SWT.

### **B.6.5. The Preferred Testing Method**

An OHS/component should be tested in a manner that most closely mimics its use at sea. It should be tested once in each of its configurations and/or modes of operation; the most adverse load geometry should be used for each test. Component tests should address both main and auxiliary features; a-frame side-arms, for example, should be tested. OHS tests should include configurations to incorporate each of its components including, but not limited to its winch, tension member, sheaves, overboard handling apparatus, and a simulated science package.

### **B.6.6. Alternative Testing Methods**

The preferred test method will be impractical or impossible to realize in many instances. These alternative testing methods may be used in lieu of the preferred test method whenever warranted.

#### **B.6.6.1. Resolution by a Subject Matter Expert**

As an alternative to the preferred test method, a test method verifying the gross capability of a component may be prepared by a subject matter expert. They may define a minimum number of test loads which will, as a whole, verify a component's integrity is sufficient to provide 125% of SWT in each of its configurations and/or modes of operation. A test load(s) must be included to validate each of a component's auxiliary features; a-frame side-arms, for example, must be tested. In no case shall a test load be defined which is in excess of a component's DLT.

Test loads should be defined with a method of application in mind. The component owner should concur with its feasibility. Whenever possible, they should be defined to enable use of the owner's existing components/equipment, in their usual location and in a typical fashion. If this is not workable, the subject matter expert should clearly stipulate the components/equipment required to develop the test loads.

#### **B.6.6.2. Laboratory Testing**

For some components, such as portable winches, blocks, and sheaves, laboratory or "bench" testing may be more practical than field testing. Such methods may be employed provided the component is loaded to 125% of its SWT in the range of geometries it's subjected to in service.

### **B.6.6.3. Piecewise Testing**

When OHS testing is not viable: if each component of the OHS has a valid test record, if it can be demonstrated that the test procedures for each component require test loads at least as great as those produced by a valid OHS test, and if these procedures include the load geometries each component sees as part of the OHS, then the sum of the component tests shall satisfy the periodic load testing requirement for the OHS.

### **B.6.7. Test Procedures**

Every load test must be conducted using a written procedure. These procedures must clearly state the amount and geometry of each test load. If the procedure is complicated, or involves components that are adjustable or portable, it must include dimensioned diagrams that clearly illustrate the reeving, location, and configuration of each component. They must specify the tension member to be used and describe both how the test load is to be developed, and how it is to be measured (when applicable). Applicable safety precautions must be included as well. Finally, pertinent MCDs and calculations must be incorporated into the test procedure; include them by reference or as an appendix to the procedure.

Procedures for deck bolts must be sufficient to ensure good physical condition; they must also state a minimum strength, and require their marking be evaluated to ensure their strength is sufficient.

### **B.6.8. Test Records**

Test logs must, as a whole, encompass every OHS and component. If it is tested singly, a component must generally have its own test log. Conversely, if a component is only subjected to OHS testing, the test log for the OHS shall satisfy the component's requirement as well. In this case, all mandatory entries pertaining to the component must be made in the OHS test log.

Test logs must be sufficient to determine the test date for each piece of standard deck hardware (e.g., deck bolts, shackles, swivels, and cleats). However, it is not required that each piece have its own test log.

Any entry into a test log must be accompanied by a date. If it pertains to a test, the entry must identify the test method or revision thereof, and the names of those who accomplished it. Entries must also be made into a test log whenever an OHS/component is inspected, repaired, or if it experiences a casualty. When made, the purpose of these entries must be clear, descriptive, and include the names of those involved.

Test logs for fixed equipment must be available both aboard the parent vessel, and in the office of the operator. Test logs for portable equipment must be kept by the owner. All test logs must be made available to representatives of regulatory agencies, such as the USCG, and those who provide oversight, such as the NSF, upon their request.

### **B.6.9. Testing Responsibilities**

If an OHS is formed by combining portable and fixed systems, the operator must produce its test procedures, assist the user by making arrangements for all required tests, and conduct them. In this case, the user must support the operator in conducting tests. At the request of the operator, the user must also assist in arranging tests, and share financial responsibility for them.

In all other cases it is the sole responsibility of the OHS/component owner to produce its test procedures and logs, to maintain its test logs, and to carry out testing at the required intervals.

### **B.6.10. Testing of Load Limiting Devices**

Testing of load limiting devices is discussed in § B.10.

### **B.6.11. Testing in Lieu of Calculation**

If the SWT of an existing OHS/component is not known, it may be determined with a load test if, following a thorough inspection, the OHS/component is found to be in safe working condition.

The load test must be performed using a procedure developed per §§ B.6.1 thru B.6.6, as they apply. The test must be followed by a careful inspection of the OHS/component. Provided the OHS/component remains in safe working condition; it does not exhibit a permanent change in shape or size, or any other indication of failure; its SWT may be as great as:

$$SWT = \text{test load} \div 1.5$$

If the SWT is established via a load test, only the tested range of load geometries may be presented and labelled as such in its MCD.

### **B.6.12. Additional Requirements for Inspected Vessels**

Inspected vessels must also comply with 46 CFR §§ 189.35-5 and 189.35-13.

## **B.7. Procedural and General Safety Requirements**

### **B.7.1. Procedural Safety Requirements**

#### **B.7.1.1. Requirements for a New OHS/Component**

If a new OHS/component will not be permanently configured and affixed to a vessel, the manufacturer must develop procedures for rigging and un-rigging it. They must include reeving and package attachment procedures whenever they are not straightforward. If its function requires input by a user, or the control of an operator, the manufacturer must develop procedures for using it to launch and retrieve packages. These procedures must emphasize the protection of the OHS/component, the vessel, the package and, most importantly, personnel.

These procedures must be continually reviewed during the design, manufacturing, and/or integration stages to ensure they remain sound and safe. They must be validated during factory acceptance trials and harbor acceptance trials as far as practicable.

Prior to the first mobilization and sea trial (if applicable), the manufacturer must prepare a detailed plan of the tests necessary to prove the OHS/component 'fit for service'. The plan must include a demonstration of requisite procedures; all participants must be rehearsed in the procedures prior to performing them.

During the first mobilization and sea trial (if applicable), the procedures must be fully demonstrated to the prospective owner or another delegated party. Wherever they are

found to be invalid, unsafe, or otherwise in need of improvement, they must be amended.

Final procedures are to be reviewed and approved by the prospective owner prior to delivery of the OHS/component. They must be incorporated into an OHS operators manual per § B.12 or an MCD component booklet per § B.11 (whichever applies) and provided to the owner upon delivery.

#### **B.7.1.2. Requirements for Existing Equipment**

If an existing OHS/component will not be permanently configured and affixed to a vessel, the owner must produce procedures for rigging and un-rigging it. They must include reeving and package attachment procedures whenever they are not straightforward.

If its function requires input by a user, or the control of an operator, the owner must produce procedures for using the OHS/component to launch and retrieve packages. These procedures must emphasize the protection of the OHS/component, the vessel, the package and, most importantly, personnel.

Final procedures are to be reviewed continuously. Wherever they are found to be invalid, unsafe, or otherwise in need of improvement, they must be amended. They must be incorporated into an OHS operators manual per § B.12 or an MCD component booklet per § B.11 (whichever applies).

#### **B.7.2. General Safety Requirements**

All moving elements shall be protected by guards or guard rail enclosures to prevent inadvertent contact by personnel in a seaway environment.

Emergency stops should be accessible at the equipment and all operator's stations.

Machinery should provide operating beacon lights to indicate when operating in order provide warning especially when equipment is remotely operated.

To the greatest extent possible, wire mesh guards, casings, and restraining posts must be used to physically exclude personnel from tension member paths and snap-back zones. In the absence of these barriers, deck safety procedures must bar personnel access to tensioned lines and snap-back zones whenever possible; they must conform to those outlined in UNOLS RVSS Appendix A, UNOLS Rope and Cable Safe Working Load Standards, at a minimum.

Where tension members are led from below deck through trunks, due regard must be taken of the potential for downflooding through the open trunks and the requisite coaming heights provided.

Any other penetrations required by the design must also take into account the need for watertight integrity of the equipment and the hull and superstructure, and be configured accordingly.

### **B.8. Training**

All OHS and/or component operators/users must receive training and be able to prove operational and safety competency. Winch operator training must be in agreement the requirements set forth in UNOLS RVSS Appendix A, UNOLS Rope and Cable Safe Working Load Standards, at a minimum.

A formal training program must be developed for each operating station; its scope should be appropriate for the complexity of the OHS/component. The program must

include general operating guidelines. Monitoring guidelines, application specific instruction, and Appendix A guidelines specific to the operation of the OHS/component shall also be included whenever applicable. Training should be conducted in a hands-on fashion whenever possible.

Training programs shall require an annual demonstration of competence and provide auditable records of initial training and competency checks. The vessel master shall be the arbiter of competence and the designator of OHS/component operators.

The owner is responsible for producing training programs for existing equipment. The program may be developed by the owner or a subject matter expert. Training programs for new equipment must be produced by the manufacturer. They are to be reviewed and approved by the prospective owner prior to delivery of the OHS/component. They must be incorporated into an OHS operators manual per § B.12 or an MCD component booklet per § B.11 (whichever applies) and provided to the owner upon delivery.

## **B.9. Labeling**

### **B.9.1. General**

An OHS/component must be labeled. The labels must include its SWT, its most recent test date and, whenever possible, an SWT diagram--a clear illustration of the tension member's allowable range of angles when loaded to its SWT. If the complexity of the OHS/component precludes such a diagram, the label must include a drawing number or make reference to an MCD or other document containing this information.

### **B.9.2. Standard Deck Hardware**

In order to be used as part of an OHS, standard deck hardware, such as deck bolts, shackles, swivels, and cleats, must be color coded or conspicuously marked in some other way to indicate they were deemed acceptable during a given test cycle. The color code or mark must change each test cycle; personnel must know which code(s)/marking(s) are indicative of acceptable hardware.

### **B.9.3. Deck Sockets**

Damaged sockets must be prominently marked. Personnel must be made aware of this mark and its meaning to prevent them from being used inadvertently.

### **B.9.4. Use Outside of Labeled Bounds**

Ship operators and their seagoing staff must understand that using an OHS/component outside of its labeled bounds could lead to the loss of valuable equipment, damage to the vessel and its fixed equipment and, in the worst case, injury to personnel. If circumstances or the desire to maintain scientific operations require a line tension or configuration outside of its labeled bounds, its safety must be confirmed by the OHS/component MCD or potentially dangerous operation may ensue.

## **B.10. Tension Mitigation Devices and Systems**

### **B.10.1. General**

As their name implies, tension mitigation devices and systems generally act to reduce line tension. Those limiting tension in an automated fashion are referred to as load limiting devices. If used on an uninspected vessel, they may allow the DLT of an OHS/component to be less than the NBL of its tension member if certain criteria are met. Others reduce, but do not limit line tension, or require user intervention; these do not allow for a reduction in the DLT in any case.

### **B.10.2. Requirements for Auto Render and Render-and-Recover**

§ B.4.5.2 allows the DLT to be less than NBL if an OHS/component features a winch designed and operated with auto render or render-and-recover. If this allowance is used, it must be clearly stated in the OHS/component MCD, which must also include the capabilities of the auto render or render-and-recover system. In order to qualify for this allowance, an auto render or render-and-recover systems must:

- B.10.2.1. Continuously monitor the loading condition of the winch.
- B.10.2.2. Be inactive when launching or recovering a science package.
- B.10.2.3. Operate continuously in all deployed modes of winch operation without requiring operator intervention.
- B.10.2.4. Provide rapid response to an overload condition, never allowing the tension member to exceed the SWT of the OHS/component.
- B.10.2.5. Be adjustable by the winch operator to enable rendering at any tension, with a maximum of 110% of the OHS/component SWT or 75% of the OHS/component DLT. Once installed as part of an OHS, the rendering tension must be no greater than the lowest component SWT.
- B.10.2.6. Retain the pre-set tension while activated, and in an overload condition. (Free spooling is not an acceptable method of rendering a tension member.)
- B.10.2.7. Signal the system is actively monitoring the loading condition of the winch with a continuous visual indicator at each operating station.
- B.10.2.8. Signal an overload condition with a continuous visual indicator at each operating station. After an overload condition, these indicators must remain activated until manually reset by the operator, or until the winch system is powered down.
- B.10.2.9. Signal an overload condition with a continuous a continuous alarm audible at the winch, the working deck areas, and each control station. The alarm must stop when the overload condition has passed.
- B.10.2.10. Automatically return the winch to full operating capability after the overload condition has passed: no operator intervention must be required.

### **B.10.3. Weak Links**

§ B.4.5.3 allows the DLT of an OHS/component to be less than NBL if it features a calibrated and tested weak link. If this allowance is used, it must be clearly stated in the OHS/component MCD, which must also include design details for the weak link, and the value of the failure load.

A weak link must be installed between the end of the tension member and the science package. It must be tested to fail at a tension no greater than the lowest component SWT, less the following: the weight of the tension member's deployed length, the maximum drag of the tension member, mass added to the tension member, and any

other forces that might be imparted on the tension member, such as those due to strumming.

Those intending to use weak links must recognize their limitations. If the science package becomes entangled it may be lost. If the tension member becomes entangled, or the required failure load is improperly estimated, a tension as great as the breaking load of the tension member may be placed on the OHS.

#### **B.10.4. Acoustic Releases**

Acoustic releases may be used to facilitate the retrieval of an otherwise lost package or section of tension member. They are not, however, considered load limiting devices.

#### **B.10.5. Remotely Operated Cutters**

A remotely-operated cutting device may be used to release an irretrievable package or to ensure the safety of a vessel in the event of an entanglement. Wherever they are installed, they must be directly controlled by the vessel master, who is the sole arbiter of the necessity and timing of their use.

Cutting devices should operate using stored mechanical energy; they must operate independently of the shipboard power system.

**Cutting devices are not considered load limiting devices.**

#### **B.10.6. Motion Compensation**

Motion compensation may be used to control the vertical position of a deployed science package, and/or to reduce the dynamic loads on an OHS/component. However, as they do not generally limit line tension, motion compensation systems are not considered load limiting devices; the DLT of an OHS/component may never be reduced solely because it features motion compensation.

Motion compensation is generally accomplished by winch pay-in/pay-out, causing an otherwise stationary tension member to be continuously worked back-and-forth over sheaves. The result is increased tension member wear, grossly accelerated by sheaves with small diameters or improper grooves.

Minimum sheave diameter and groove requirements are set forth in UNOLS RVSS Appendix A, UNOLS Rope and Cable Safe Working Load Standards. If possible, these requirements should be exceeded whenever motion compensation is employed in order to minimize its deleterious effect on the tension member.

### **B.11. The MCD Component Booklet**

Generally, an MCD component booklet must be assembled for each component. It must contain:

- The component MCD per § B.5
- The component's overall dimensions in each of its configurations
- Component test procedures and records per § B.6
- Procedural safety requirements per § B.7
- Operator training procedures and records per § B.8
- Preventative maintenance procedures and their frequency

If the component is portable, the booklet must also contain:

- The component's weight
- Ship service and ship interface requirements, such as electrical power, hydraulic power, and automated data collection
- An inventory of spares

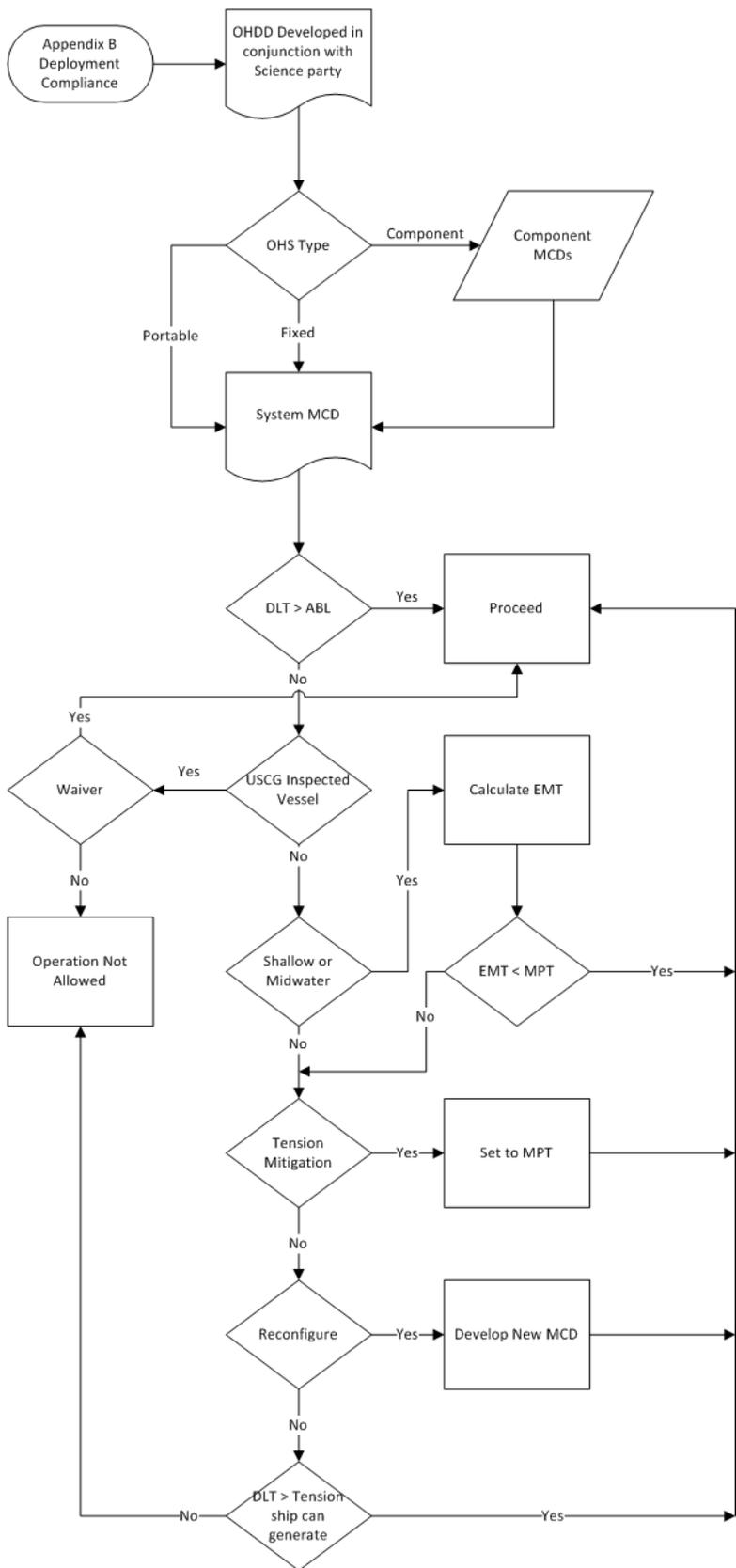
MCD component booklets are not required for tension members or standard deck hardware. If a component's nature precludes the contents outlined above, or if these contents are included in its MCD, it does not require an MCD component booklet.

## **B.12. The OHS Operator's Manual**

An OHS operator's manual must be assembled for each OHS, excepting those formed by combining portable and fixed equipment. The OHS operator's manual must contain:

- An OHS MCD per § B.5
- An MCD for each component per § B.5
- A reference to each applicable MCD component booklet
- A 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
- OHS test procedures and records per § B.6
- Procedural safety requirements per § B.7
- Operator training procedures and records per § B.8

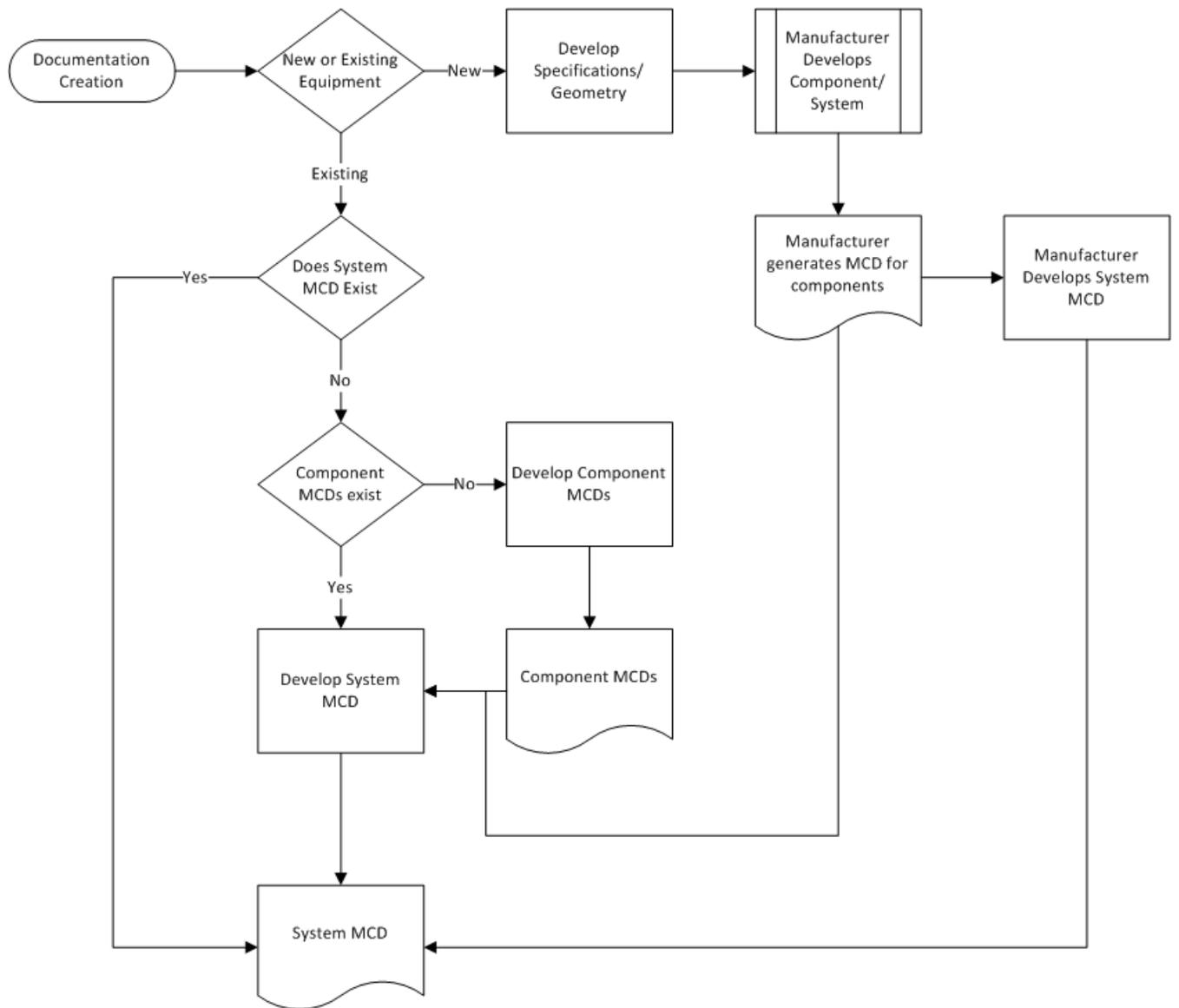
# Attachment B.1: Appendix B Deployment Compliance Flow Chart



## Attachment B.2: Overboard Handling Data Document

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	

### Attachment B.3: The MCD Development Process



## Attachment B.4: Sample System MCD (2 pages)

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# System MCD

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### *Mixed System of Portable and Fixed Equipment*

This document has been prepared in accordance with Appendices A & B from the UNOLS RVSS. This system is rated for all deployment types referred to by Appendix B section B.3.5. Due to the lack of tension monitoring system, the tension member is limited to a safety factor of 5.

Section	Operation	Allowed
B.3.5.1	Towing – Surface	Y
B.3.5.2	Towing - Mid Water	Y
B.3.5.3	Towing - Deep Water	Y
B.3.5.4	Station Keeping – Surface	Y
B.3.5.5	Station Keeping – Mid Water	Y
B.3.5.6	Station Keeping – Deep Water	Y

### Component MCDs

Component	MCD	Supplied By:
Deck Sockets	Ship Deck Socket MCD	Ship
Deck Bolts	Manufacturers Data Sheet	Ship
Winch	UWP Portable Winch MCD	UNOLS Winch Pool
Tension Member	Manufacturers Data Sheet	User
Sheave	UWP Sheave MCD	UNOLS Winch Pool
Shackle	Ship Shackle MCD	Ship
A-Frame	Ship A-Frame MCD	Ship
EMT	OHDD	User

### Component Characterizations

Deck Socket Characteristics	Value from MCD
SWT / DLT Tension	5,000 lbf
SWT / DLT Shear	8,000 lbf

Deck Bolt Characteristics	Value from Data Sheet
SWT	20,500 lbf
DLT	102,000 lbf

Winch Characteristics	Value from MCD
SWT	4,500 lbf
SWT Reaction at Deck	775 lbf
DLT	12,000 lbf
DLT Reaction at Deck	4,090 lbf

Wire Characteristics	Value from Data Sheet & MCD
SWT	2,320 lbf
NBL	11,600 lbf

Sheave Characteristics	Value from MCD
SWT	10,000 lbf
SWT Reaction	20,000 lbf
DLT	20,000 lbf
DLT Reaction	40,000 lbf

Shackle Characteristics	Value from MCD
DLT	22,680 lbf
SWT	13,500 lbf

A-Frame Characteristics	Value from MCD
SWT Towing	10,000 lbf
DLT Towing	20,000 lbf
SWT Station Keeping	14,140 lbf
DLT Station Keeping	30,000 lbf

Science Package Characteristics	Value From OHDD Work Sheet
Package	Sub-Bottom Profiler
Water Depth	500 m
Cable Length	1,000 m
EMT	1,809 lbf

### System Characterization

System Characteristics	Value from Components
EMT	1,809 lbf
SWT	2,320 lbf
DLT	11,600 lbf
Deployment Types	Deep Water Towing and Station Keeping

## Attachment B.5: Deck Socket MCD Example (2 pages)

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# Maximum Capability Document

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### *Ship Deck Socket*

This document has been prepared in accordance with Appendices A & B from the UNOLS RVSS. This deck socket is rated for all deployment types referred to by Appendix B section B.2.1 depending on geometry and the tension member selected. If the load could exceed the ratings a load limiting device or system must be employed.

Section	Operation	Allowed
B.2.1.1	Towing – Surface	Y
B.2.1.2	Towing - Mid Water	Y
B.2.1.3	Towing - Deep Water	Y
B.2.1.4	Station Keeping – Surface	Y
B.2.1.5	Station Keeping – Mid Water	Y
B.2.1.6	Station Keeping – Deep Water	Y

### System Characterizations

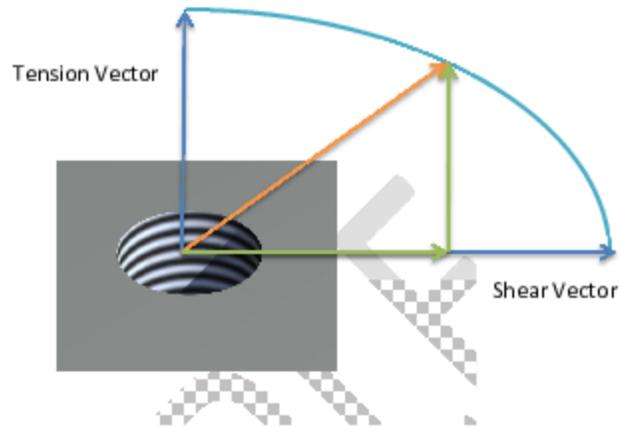
In the case of Deck sockets the DLT and SWT refer to forces directly acted upon them.

Tension DLT <sup>1</sup>	5,000 lbf
Tension SWT <sup>2</sup>	5,000 lbf
Shear DLT <sup>2</sup>	8,000 lbf
Shear SWT <sup>2</sup>	8,000 lbf

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<sup>1</sup>Tension DLT/SWT is the pull perpendicular to the ship's deck

<sup>2</sup>Shear DLT/SWT is the pull parallel to the ship's deck



Angle	Tension Vector	Shear Vector	Combined Vector
0	0 lbf	8000 lbf	8000 lbf
10	850 lbf	7875 lbf	7900 lbf
20	1700 lbf	7500 lbf	7700 lbf
30	2500 lbf	6900 lbf	7350 lbf
40	3200 lbf	6100 lbf	6900 lbf
50	3800 lbf	5100 lbf	6400 lbf
60	4300 lbf	4000 lbf	5875 lbf
70	4650 lbf	2700 lbf	5400 lbf
80	4900 lbf	1375 lbf	5100 lbf
90	5000 lbf	0 lbf	5000 lbf

## Attachment B.6: Winch MCD (2 pages)

# UNOLS Winch Pool

Engineer, UNOLS Winch Pool  
UNOLS Facility

## Maximum Capability Document

### UWP Portable Winch

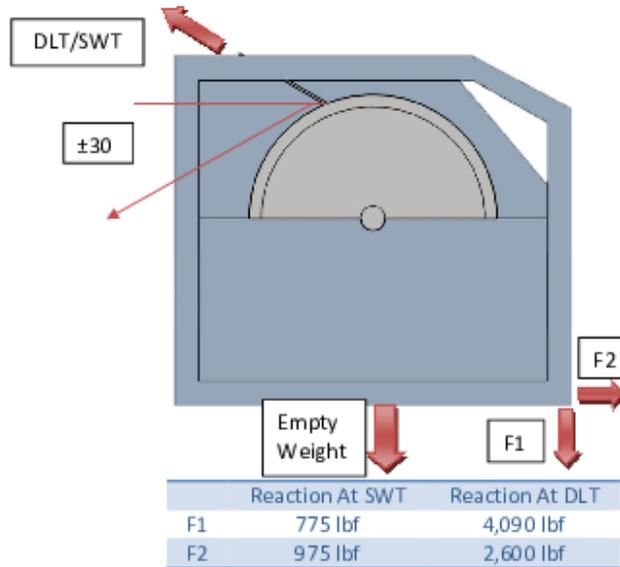
This document has been prepared in accordance with Appendices A & B from the UNOLS RVSS. This machine is primarily used for 0.322 tension members, with an 11,600 lbf breaking strength. Per Appendix A, the machine in its' current configuration is limited to a Factor of Safety (FS) of 5.0 on the tension member due to the lack of cable monitoring system. The FS on the tension member could be lowered if a monitored over-boarding block is employed in accordance with Appendix A. Per Appendix B this machine is rated for "Lifting & Towing - Deep Water" (Section B.3.5.2 & 5) with .322 or weaker tension members. Stronger tension members are limited to "Lifting & Towing - Mid Water" as currently configured due to the lack of load limiting equipment; this strictly limits tension member deployed length to 75% of water depth. This machine could be rated for "Lifting and Towing - Deep Water" with stronger tension members if proper load limiting equipment were employed per Appendix B.

Section	Operation	Allowed
B.3.5.1	Towing – Surface	Y
B.3.5.2	Towing - Mid Water	Y
B.3.5.3	Towing - Deep Water	Y
B.3.5.4	Station Keeping – Surface	Y
B.3.5.5	Station Keeping – Mid Water	Y
B.3.5.6	Station Keeping – Deep Water	Y

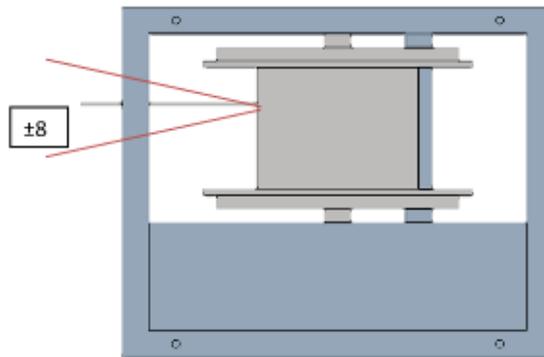
### System Characterizations

Empty Weight	5,000 lbf
Maximum Weight	6,500 lbf
Safe Working Tension (SWT)	4,500 lbf
Design Line Tension (DLT)	12,000 lbf
Maximum Speed at Bottom Layer	40 m/min
Maximum Oil Operating Temperature	180 F
Power Requirements	3 Phase 480VAC 60 Hz 60 Amp Circuit

## Free Body Diagram



Forces are maximum forces per bolt, at SWT & DLT, for a 4 bolt hold down pattern (Rows spaced at 48"). Analysis is good for a vertical fleet angle of  $\pm 30^\circ$  and a horizontal fleet angle of  $\pm 8^\circ$ .



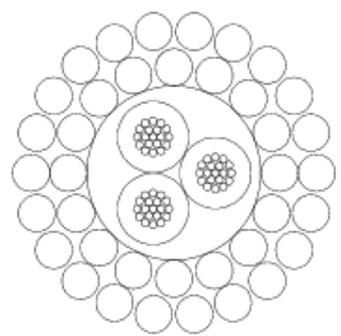
# Attachment B.7: Tension Member Data Sheet as an MCD (2 pages)

751 Old Brandy Road  
Culpeper, Virginia 22701

Tele: 540 825-2111  
Fax: 540 825-2238

## DATALINE®

Description	Inch	mm
<b>INSULATED CONDUCTOR (3)</b>		
Cdr: #19 AWG (19/0.008") Bare Cu	0.039	0.99
Ins: .016" wall Polypropylene	0.071	1.80
<b>ASSEMBLY</b>		
3 ins. cdrs. cabled	0.153	3.89
<b>BELT</b>		
0.015" wall HD Polyethylene	0.183	4.65
<b>ARMOR - 2 layers</b>		
16/0.0375" GEIPS	0.247	6.27
22/0.0375" GEIPS	0.322	8.18



PROPRIETARY; Use Pursuant to Company Instructions



Instrumentation & Control Cable Code: I10030152PO00			
<b>Date</b>	<b>Page</b>	<b>Revision</b>	<b>Part No.</b>
11/20/2008	1	U	A301592

**PERFORMANCE CHARACTERISTICS**

Nominal Values @ 20°C	Metric	English
<b>PHYSICAL</b>		
Weight in Air	257 kg/km	173 lb/kft
Weight in Seawater	212 kg/km	143 lb/kft
Specific Gravity (SG = 1.028)	5.7	5.7
<b>MECHANICAL</b>		
Breaking Strength, Fixed End	52 kN	11,600 lbf
Breaking Strength, Free End	45 kN	10,000 lbf
Working Load @ .4% Strain	11 kN	2,500 lbf
Maximum Working Load <sup>1</sup>	22.2	5,000 lbf
Recommended Bend Radius	15 cm	6"
Rotation @ 2,500 lbf	49°/m	15°/ft
<b>ELECTRICAL</b>		
Voltage Rating	1,000 V	1,000 V
Insulation Resistance	3,000 MΩ•km	10,000 MΩ•kft
dc Resistance		
Cdr.	30.8 Ω/km	9.4 Ω/kft
Armor	7.9 Ω/km	2.4 Ω/kft
Capacitance (cdr.-armor)	115 pF/m	35 pF/ft

<sup>1</sup>The cable working load as stated on the DATALINE (2,500 lbf) represents the maximum quasi-static load of the operational system that will be supported by the cable. Transient dynamic loads may be applied to the cable providing that the maximum dynamic load applied remains below 5,000 lbf and its period is smooth and gradual, greater than several seconds. Caution must be taken with rapid fluctuations in the loading condition that will result in conductor buckling (compression, otherwise known as "z" kinking). These rapid load variations include, but are not limited to, shock loading, the rapid and erratic removal and increasing of load. This load transient has a period less than a few seconds and can result in cable buckling and/or hocking. Extended excursions above the working load value may affect service life and increases the risk of component buckling."

PROPRIETARY; Use Pursuant to Company Instructions



Instrumentation & Control Cable			
Code: I10030152PO00			
Date	Page	Revision	Part No.
11/20/2008	2	U	A301592

## Attachment B.8: Sheave MCD Example

# UNOLS Winch Pool

Engineer, *UNOLS Winch Pool*  
*UNOLS Facility*

## Maximum Capability Document

### *UWP Sheave*

This document has been prepared in accordance with Appendices A & B from the UNOLS RVSS. This Hanging sheave has been designed for use with 0.322 & 0.393 cable and 5/16 wire rope. The sheave grooving is in accordance with Appendix A for a safety factor of 5-2.5. This sheave is rated for all deployment types referred to by Appendix B section B.2.1.

Section	Operation	Allowed
B.2.1.1	Towing – Surface	Y
B.2.1.2	Towing - Mid Water	Y
B.2.1.3	Towing - Deep Water	Y
B.2.1.4	Station Keeping – Surface	Y
B.2.1.5	Station Keeping – Mid Water	Y
B.2.1.6	Station Keeping – Deep Water	Y

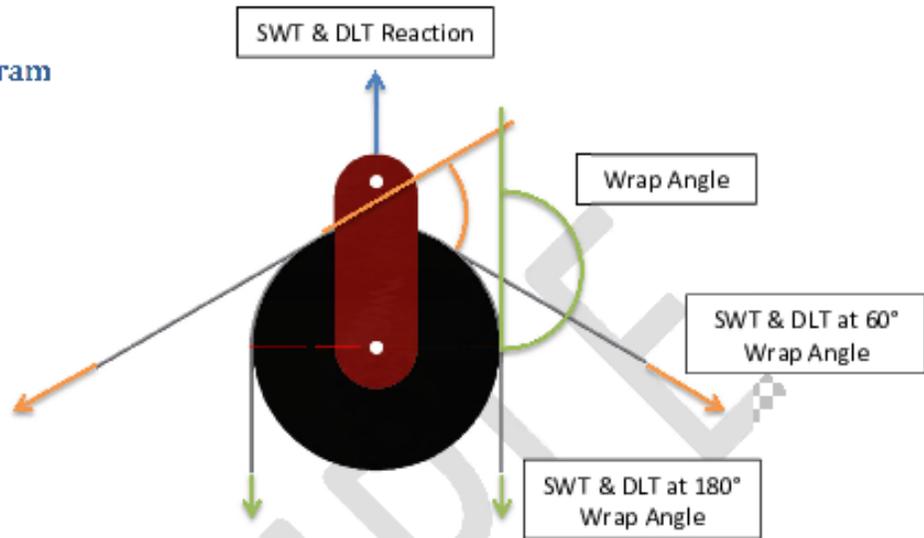
### System Characterizations

Manufacturer's FS	5.0
Appendix A FS	2.5
Manufacturer's SWL	20,000 lbf
Minimum SWT <sup>1</sup>	10,000 lbf
Minimum DLT <sup>1</sup>	20,000 lbf
Wrap Angle <sup>1</sup>	180°
Maximum SWT <sup>1</sup>	< 20,000 lbf
Maximum DLT <sup>1</sup>	< 40,000 lbf
Wrap Angle <sup>1</sup>	> 60°
Weight	115 lbf
DLT Reaction Load <sup>2</sup>	40,000 lbf
SWT Reaction Load <sup>2</sup>	20,000 lbf
Groove Diameter	0.45 in
Tread Diameter	18 in

<sup>1</sup> SWT/DLT changes as the wrap angle changes. In some cases some tension members may be limited to certain angles.

<sup>2</sup> The Reaction Load is based on DLT/SWT at any angle

## Free Body Diagram



The reaction force is constant over the SWT/DLT range. Using the table below it is possible to estimate the SWT/DLT based on a given geometry and use.

Wrap Angle	SWT	SWT Reaction	DLT	DLT Reaction
180°	10,000 lbf	20,000 lbf	20,000 lbf	40,000 lbf
165°	10,090 lbf	20,000 lbf	20,170 lbf	40,000 lbf
150°	10,350 lbf	20,000 lbf	20,170 lbf	40,000 lbf
135°	10,820 lbf	20,000 lbf	21,640 lbf	40,000 lbf
120°	11,550 lbf	20,000 lbf	23,090 lbf	40,000 lbf
105°	12,600 lbf	20,000 lbf	25,200 lbf	40,000 lbf
90°	14,140 lbf	20,000 lbf	28,280 lbf	40,000 lbf
75°	16,430 lbf	20,000 lbf	32,850 lbf	40,000 lbf
60°	20,000 lbf	20,000 lbf	40,000 lbf	40,000 lbf
45°	26,130 lbf	20,000 lbf	52,260 lbf	40,000 lbf



## Attachment B.9: Shackle MCD Example

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# Maximum Capability Document

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### *Ship Shackle*

This document has been prepared in accordance with Appendices A & B from the UNOLS RVSS. This a-frame is rated for all deployment types referred to by Appendix B section B.2.1 depending on geometry and the tension member selected. If the load could exceed the ratings a load limiting device or system must be employed.

Section	Operation	Allowed
B.2.1.1	Towing – Surface	Y
B.2.1.2	Towing - Mid Water	Y
B.2.1.3	Towing - Deep Water	Y
B.2.1.4	Station Keeping – Surface	Y
B.2.1.5	Station Keeping – Mid Water	Y
B.2.1.6	Station Keeping – Deep Water	Y

### System Characterizations

Shackle Type	Crosby G-2130
Shackle Size	1-3/8
Ultimate Strength <sup>1</sup>	113,400 lbf
Working Load Limit	27,000 lbf
DLT <sup>2</sup>	22,680 lbf
SWT <sup>3</sup>	13,500 lbf

<sup>1</sup> Calculated as 70% of Ultimate Load for cases of side loading up to 45°

<sup>2</sup> DLT incorporates a factor of safety of 1.5 to Yield and assumes a 180° wrap angle

<sup>3</sup> SWT incorporates a factor of safety of 1.7 to DLT and assumes a 180° wrap angle

## Attachment B.10: A-Frame Example MCD (2 pages)

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# Maximum Capability Document

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### *Ship A-Frame*

This document has been prepared in accordance with Appendices A & B from the UNOLS RVSS. This a-frame is rated for all deployment types referred to by Appendix B section B.3.5 depending on geometry and the tension member selected. If the load could exceed the ratings a load limiting device or system must be employed.

Section	Operation	Allowed
B.3.5.1	Towing – Surface	Y
B.3.5.2	Towing - Mid Water	Y
B.3.5.3	Towing - Deep Water	Y
B.3.5.4	Station Keeping – Surface	Y
B.3.5.5	Station Keeping – Mid Water	Y
B.3.5.6	Station Keeping – Deep Water	Y

### System Characterizations

Station Keeping Parameters	Maximum Capability Value
Station Keeping SWT <sup>1</sup>	10,000 lbf
Station Keeping DLT <sup>2</sup>	20,000 lbf
Maximum Side Angle	30° (Cone)
Maximum Vertical Angle	30° (Cone)
Nominal Wrap Angle	125° (Cone tolerance 95°-155°)

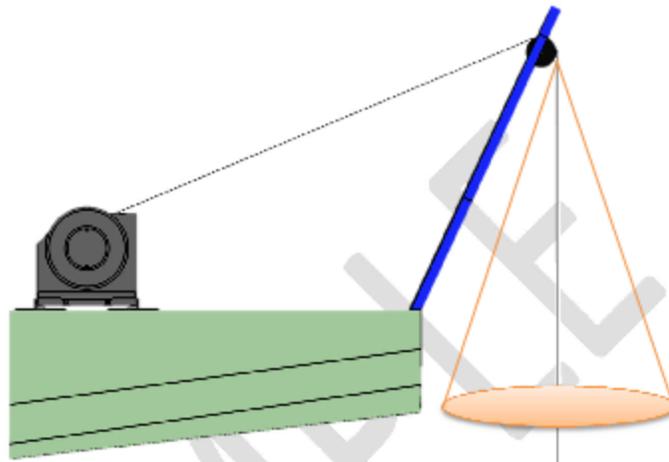
Towing Parameters	Maximum Capability Value
Towing SWT <sup>1</sup>	14,140 lbf
Towing DLT <sup>2</sup>	30,000 lbf
Maximum Side Angle	30°
Maximum Vertical Angle	35°
Maximum Wrap Angle	90°

<sup>1</sup> Working Tension

<sup>2</sup> Tension where there is a 1.5SF to yield on metal components

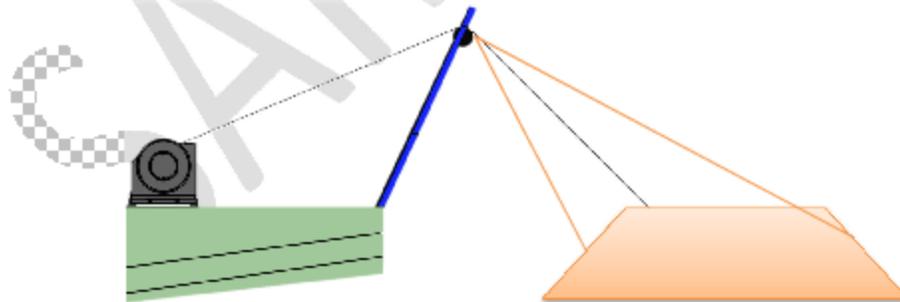
## Free Body Diagrams

### Station Keeping



The station keeping SWT and DLT are based on the worst case analysis of a 30° cone around an idealized vertical tension member.

### Towing



The towing SWT and DLT are based on the worst case analysis of a 30° side angle outboard of the A-Frame and a 15° swath inboard of an idealized 45° tension member.

**Attachment B.11: OHDD Example**

Primary Deployment Information:	Science Party Response
Deployment Type	<i>Deep Water Towing</i>
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.	<i>Towing a sub bottom profiler to exam water column properties.</i>
Package Type	<i>Edge Tech Sub Bottom Profiler, Tow Fish</i>
Maximum Package Weight (in water) (lbf)	<i>350</i>
Maximum Package Mass (weight in air) (lbm)	<i>500</i>
Added Weight (in water) (lbf)	<i>0</i>
Added Mass (weight in air) (lbm)	<i>0</i>
Maximum Drag (lbf)	<i>180</i>
Maximum Extraction Force (lbf)	<i>0</i>
Maximum Anticipated Tension Member Deployment Length (m)	<i>1000</i>
Deployment Depth (m)/ Water Depth (m) /Max %	<i>475 / 500 / 95%</i>
OHS/Components Furnished by Science Party	<i>Tension Member</i>
Vessel Services Required	<i>A-Frame</i>
Tension Member Type	<i>0.322 EM</i>
Maximum Tension Member Weight (in water) (lbf)	<i>474</i>
Maximum Tension Member Mass (weight in air) (lbm)	<i>573</i>
Tension Member ABL/SWT@FS (lbf)	<i>11,600/2,320 @5.0</i>
Load Mitigating Devices	<i>None</i>