BH-USA

EVERYTHING FOR YOUR DOCK & PIER

WIRE ROPE

TECHNICAL GUIDE FOR BOAT LIFTS

25316 RVSD. 9/2020

WARNING

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The wire rope that BH-USA sells is mill-tested to meet certain specifications, some of which are described in this Technical Guide. However, BH-USA does not manufacture wire rope, and **BH-USA MAKES NO WARRANTIES REGARDING WIRE ROPES SOLD OR SUPPLIED BY BH-USA, AND BH-USA EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. ALL WIRE ROPES ARE SOLD ON AN "AS IS, WHERE IS" BASIS. THIS TECHNICAL GUIDE, ALONG WITH ANY ADVICE OR RECOMMENDATIONS PROVIDED BY BH-USA, IS FOR INFORMATIONAL PURPOSES ONLY, AND BH-USA MAKES NO REPRESENTATION OR WARRANTY REGARDING THE ACCURACY OR SUFFICIENCY OF SUCH INFORMATION OR ITS APPLICABILITY TO ANY PRODUCTS SOLD BY BH-USA, NOR DOES BH-USA ASSUME ANY OBLIGATION OR LIABILITY FOR SUCH INFORMATION.**

CABLE SIZE FOR WEIGHT OF BOAT BEING LIFTED

Lift	1 Part Straight Line	2 Part Compounded
2,800 lbs.	3/16	3/16
4,500 lbs.	1/4	3/16
6,000 lbs.	5/16	1/4
9,000 lbs.	x	1/4
10,000 lbs.	x	1/4
13,000 lbs.	x	5/16
16,000 lbs.	x	3/8
24,000 lbs.	x	3/8*

* with reduced SF

BH-USA assumes no responsibility or liability for installations and/or improper use of the equipment. This guide is intended to be used as a reference and general guideline only. **BH-USA** is not responsible for the design, construction or installation of docks, piers or lifts.

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* See BH-USA Limited Warranty Information on the inside back cover of this publication.

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BH-USA
EVERYTHING FOR YOUR DOCK & PIER

All accounts and BH-USA customers

September 2020

Company Action on Wakeboard Boats
Cable ratings and 7x19 aircraft cable usage

It has come to our attention that wakeboard and ski boats are now being manufactured with ballast tanks capable of adding thousands of pounds to the boat. It has also become evident that in many cases installers are not considering this added wet weight when determining proper cable size and lift design.

What is the issue?

Reports of cable breaking have increased in the last few years, Almost all cases involve wakeboard type boats being lifted with cable that is too small for the weight of the boat being lifted. Experienced installers are failing to adequately configure the lift by not taking into consideration the total weight of the boat including the added water ballasts.

What is our response?

BH-USA, in an effort to help installers better understand 7x19 cable and how to adequately gauge boat weights, Has commissioned a cable and rating guide that can be found by following the QR code available on this letter, or visit www.bh-usa.com/instructions-manuals/. If neither is an option please give us a call at 844-367-5806. This guide will help installers and end users determine the size lift and proper cable size for the boats that are being lifted.

What should you do?

Follow our guides and recommendations. BH-USA supplies guides to help you configure install and properly rate a lift. We recommend sharing these guides with your customers so they have a better understanding. If an end user or your customer disagrees with our guides and recommendations we highly suggest getting a waiver from your customer.

BH-USA position:

BH-USA will only recognize the maximum wet weight of a boat when considering warranty issues, liability or trouble shooting. BH-USA will provide technical and design recommendations and help by publishing charts and equipment guides. BH-USA will only recognize the safe working load of cable when determining lift ratings as per the recommendation of the American Society for Mechanical Engineers (ASME)

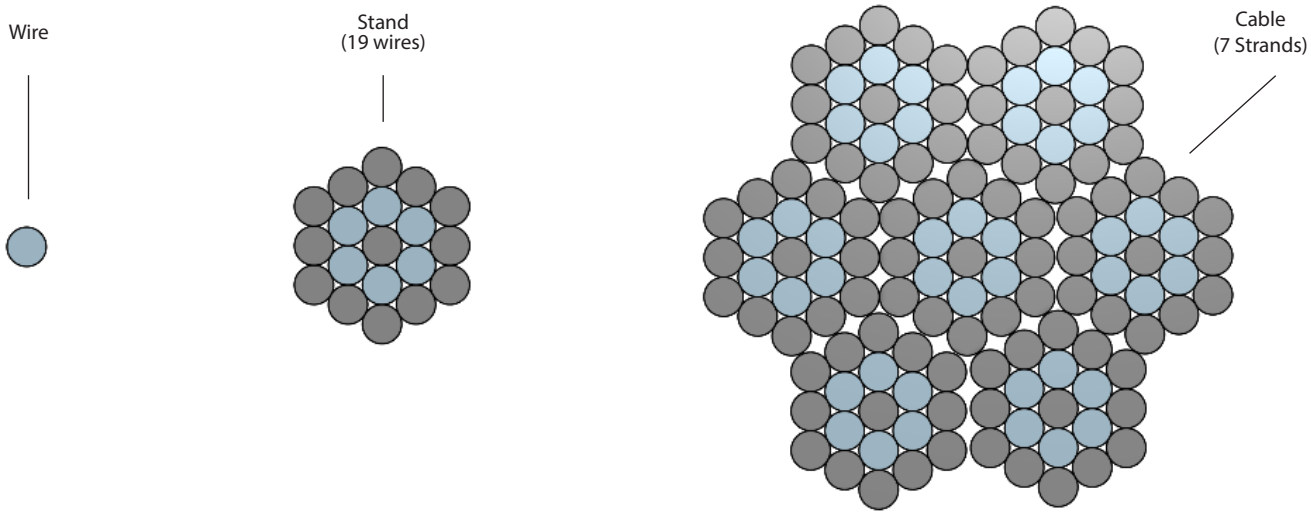
Thank you for your attention to this important matter.

It's simple, use your smart phone camera option and hover over the QR code to be given a link to our technical guides.

This guide is provided to help the end user or installer in determining which size cable is required to safely lift your boat and expect the longest life out of your lift. There are many factors that affect how much weight a wire rope can safely hold. It is also important to know that the wire rope is a system of components which is only as strong as the weakest link.

Construction

Wire rope or cable is comprised of steel or stainless steel wires twisted together into bundles called strands and further twisted together into the final wire rope/cable. This type of wire rope construction commonly used on boat lifts is specified to by the number of wires and strands. For example, a 7x19 cable will have 7 strands with 19 wires in each strand.



Safe Working Load vs. Minimum Breaking Strength

It is important to use the Safe Working Load (SWL) of the cable and not the breaking strength when selecting wire rope. The breaking strength is just that… the amount of force a brand-new wire rope can hold in a perfect world where if you put one more pound on it would cause it to SNAP!

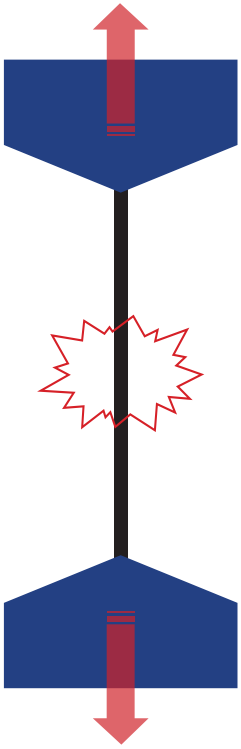
Why don't we use the breaking strength?

The breaking strength of wire rope is tested using a machine that isolates just the wire rope so that the end connections do not affect the overall strength.

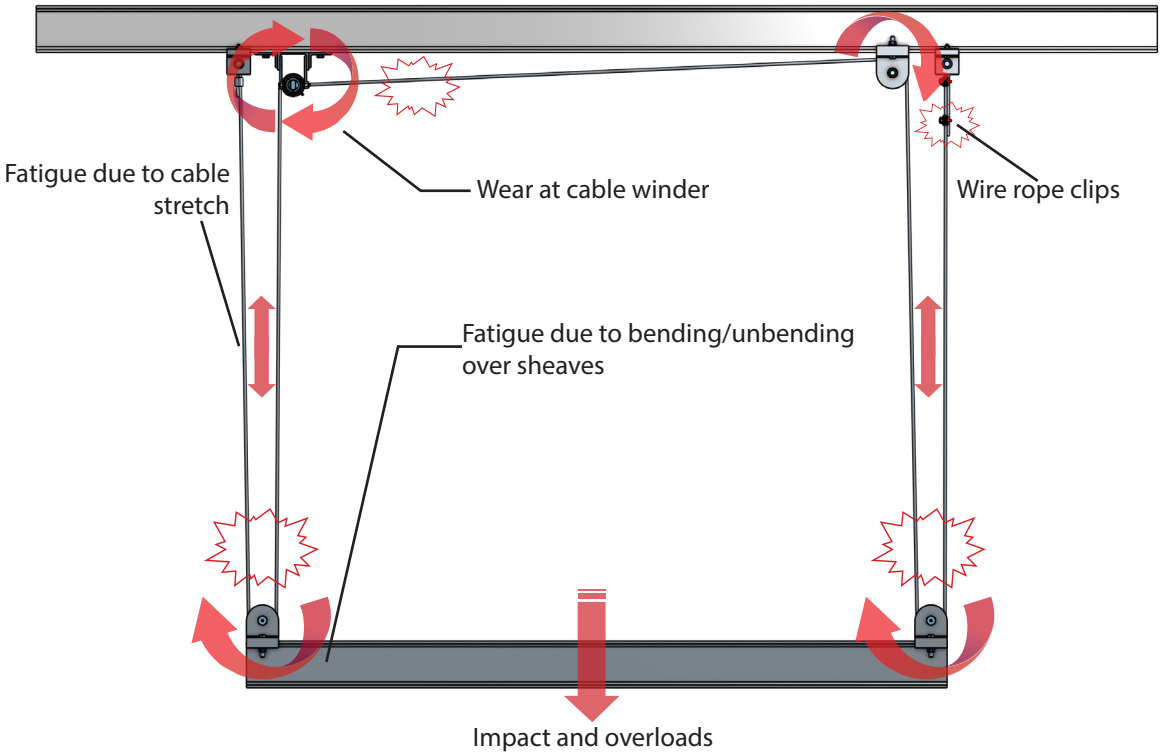
In the real world, the wire rope is system of components including the wire rope itself and the end connections working together dynamically which have to bend around sheaves and cable winders and are only as strong as the weakest link.

The minimum breaking strength is simply a measure of how much tension the wire rope can withstand in a perfect scenario that does not take in to consideration the other factors that reduce the capacity of the wire rope system in a boat lift.

Pure Tension Test



Real World



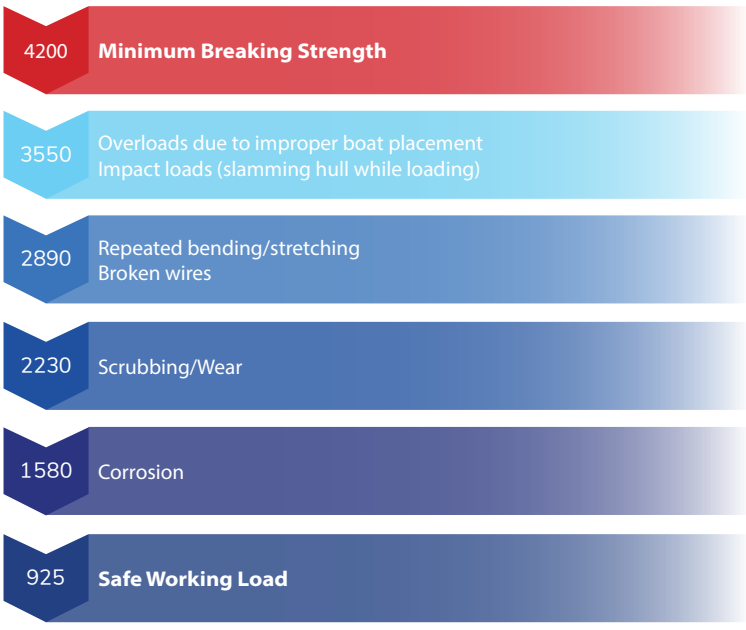
Why is the rating so low?

The Safe Working Load includes a safety factor (SF) to allow for all the things that can happen to wire rope during its useful life that will reduce the breaking strength.

The safety factor is a recommendation from the American Society for Mechanical Engineers (ASME) for this type of equipment such that the lift can still safely hold the load when some or all factors working to break the wire rope are present.

Safety factor gets "used up" as the wire rope deteriorates effectively lowering the breaking strength.

In the next steps we will determine the loads that each wire rope will be exposed to and then will choose a wire rope size with a SWL rating higher than the maximum loads.



BH-USA provides both stainless steel cable and galvanized steel cable in the following sizes:

Wire Rope Dia.	Min. Breaking Strength Galv. Steel	Min. Breaking Strength SS	SWL Galv. Steel	SWL SS
3/16	4,200	3,700	1,050	925
1/4	7,000	6,400	1,750	1,600
5/16	9,800	9,000	2,450	2,250
3/8	14,400	12,000	3,600	3,000

The first step in deciding what size wire rope is required for your lift is to determine the total weight of to be lifted which will include the "wet" weight of the boat, the maximum estimated cargo that could be put in the boat during the lift and the weight of the lifting cradle

- Boat
- Fuel
- Water (Ballast, live well, potable, etc.)
- Any cargo items in the boat (Note: There should never be people in the boat while being lifted.)
- Boat cradle and bunks

The boat weight specified by a manufacturer is typically the "dry" weight of the boat. To get the "wet" weight, you must include the weight of the fuel (gasoline is 6.30 lb/US gal and diesel is 6.94 lb/US gal), the weight of any water (8.34 lb/US gal) that may ever be present in the boat and the estimated weight of possible cargo (ie – coolers, skis, etc.).

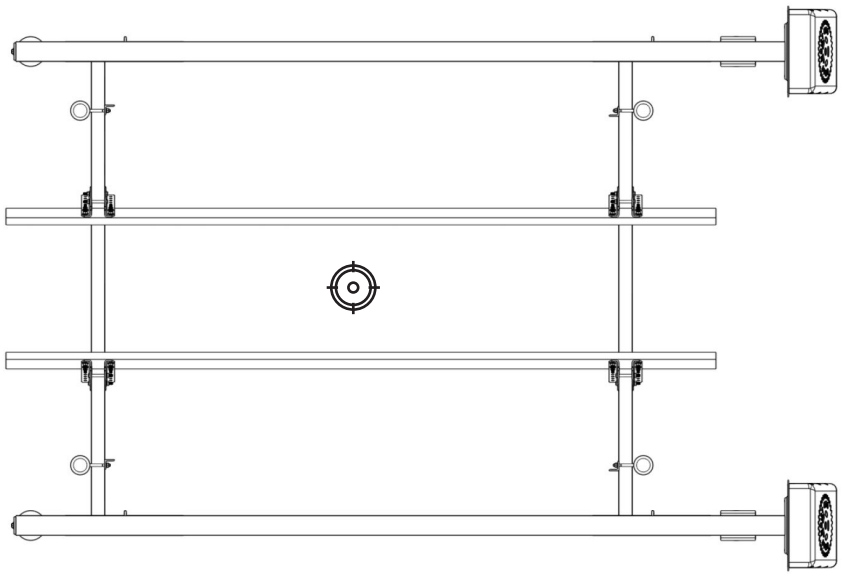
23' Wake Boat
Table 2

Boat Dry WT	6,000 LBS
Fuel WT	410 LBS
Water WT	4,087 LBS
Boat Wet WT*	**10,496 LBS**
Cargo WT	250 LBS
Cradle & Bunk WT	300 LBS
Total Lifted Weight	**11,046 LBS**

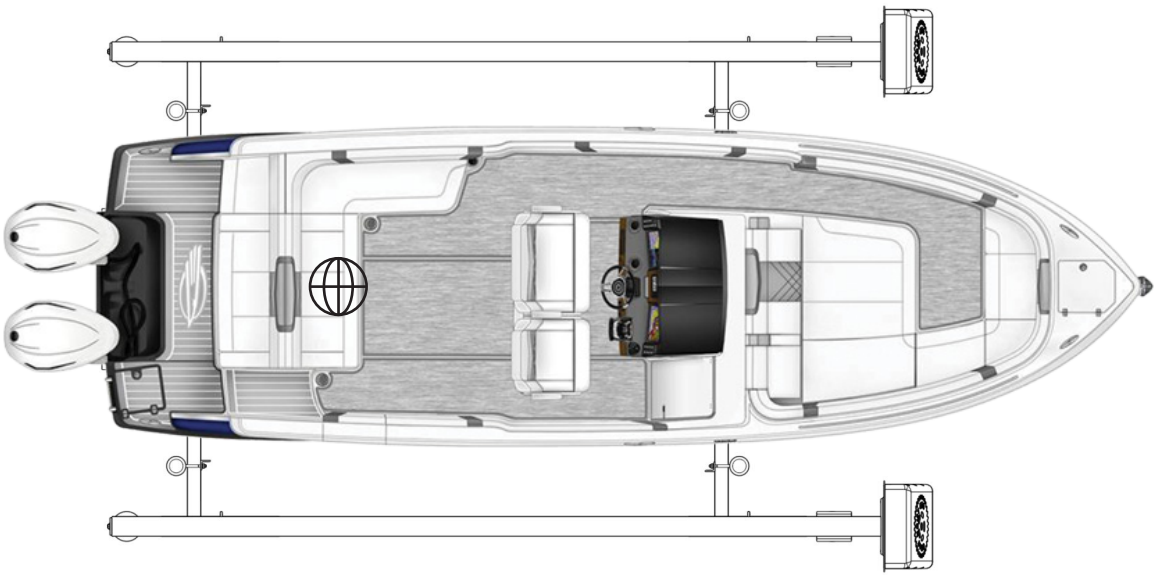
*** Some water weight, especially if the water weight is a significant percentage of the total lifted weight, should be included in the total weight calculation as a precaution against over loading the lift if the water is not drained before lifting the boat.**

After determining the total weight to be lifted, the next step is to decide where the weight will be in relation to the cradle lift points. The CG is the balance point of the craft if you were to pick it up at one single point.

The location of the CG in relation to the lift points could cause the tension in the cables to be higher than if the CG were centered between all the lift points.



The ideal location of the CG is centered between the cradle beams and side to side, the CG of typical power boats tends to be over the after 1/3 as shown which means the tension is greater toward the after end.

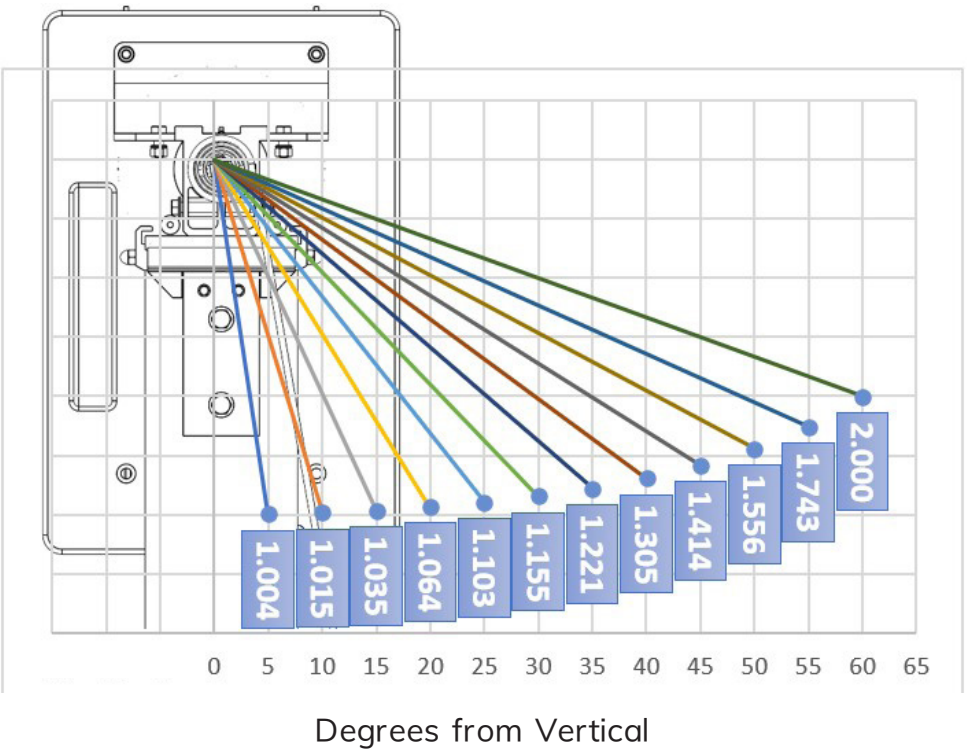


Additionally, the tension in the cable will increase if the CG of the boat is not centered between the cable lift points and will be highest on the cable that is closest to the CG location.

Cable Lifting Angle

The amount of tension in a cable increases the farther the cable is pulled from vertical. This is especially true when using slings or if the upper part of the lift is wider than the cradle beam attachment point. The following factor must be applied to the tension in the cable for every degree from vertical.

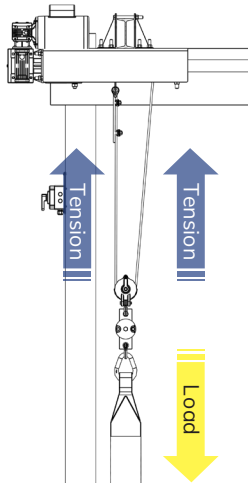
Degrees from Vertical	Tension Multiplier
5	1.00
10	1.02
15	1.04
20	1.06
25	1.10
30	1.15
35	1.22
40	1.31
45	1.41
50	1.56
55	1.74
60	2.00



The cable may be 5° from vertical when the lift is fully lowered but depending on the geometry of the installation, the cables may be at 35° from vertical when the lift is fully raised. The tension will increase from 1.004 times the straight-line vertical tension to 1.221 times (22.1%).
The cables need to be installed as close to vertical to prevent possibly overloading the cables and other supporting structures.

Compounding

If the per cable tension is too high, the cable may need to be compounded. Compounding involves adding a pulley to the line and attaching the "dead end" to a fixed structure capable of holding the line tension.



This reduces the amount of tension in the line by a factor of 2 because the load pulling down from the corner lift point is shared between two lines instead of one.

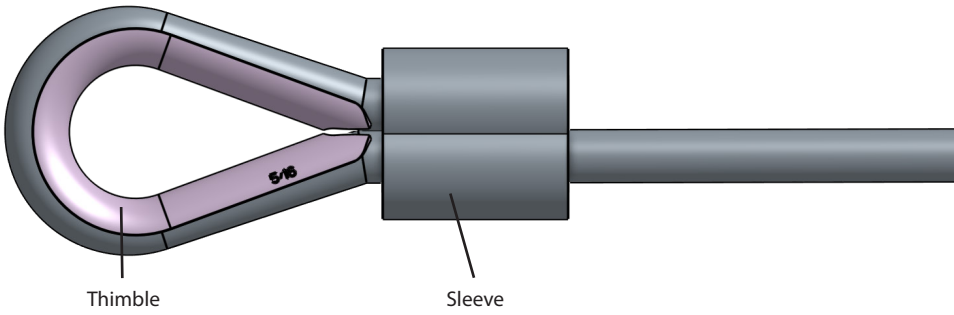
The "live end" is still wrapped around the drive pipe or cable winder as usual. This configuration while reducing the tension in the cable also requires double the amount of cable to lift the boat for the same distance. The lift time will also be doubled for the same rotational speed of the drive pipe.

End Terminations

The two primary means of creating wire rope end terminations on boat lifts use either (1) a swaged, zinc-coated copper sleeve or (2) wire rope clips in combination with a thimble to create an end loop suitable for lifting. The end terminations are not as strong as the breaking strength of the cable itself and must be considered in the capacity of the wire rope system of components.

Swaged Sleeve

The swaged sleeve is the strongest of the two connections and is a permanent means of creating an end loop. It requires the use of a swaging tool to crimp multiple places on the sleeve. A thimble is used to protect the wire rope strands.



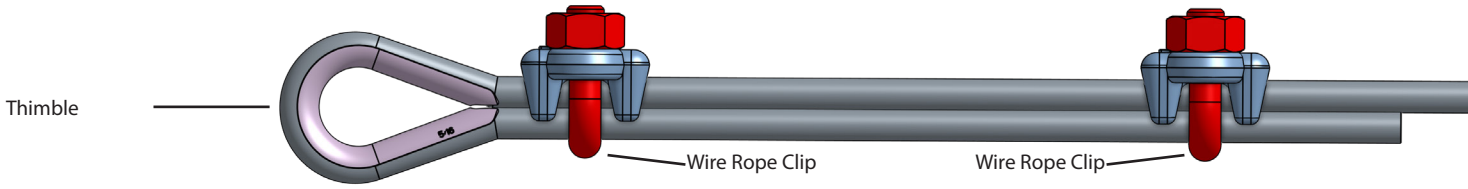
BH-USA recommends only using zinc-coated copper sleeves for use in marine environments or sudden catastrophic failure can occur.

A swaged sleeve connection retains 90% of the strength of the plain wire rope.

Wire Rope Clip

Though not as strong as a swaged connection, the use of wire rope clips creates an adjustable connection without the use of the special tooling. It is important to install the correct number wire rope clips in the correct orientation at the proper spacing to achieve the maximum holding strength.

A connection with wire rope clips retains 80% of the strength of the plain wire rope.



You must multiply the SWL of the wire rope by .8 to get the SWL of the connection.

Table 3

Wire Rope Dia.	SWL* Galv. Steel	SWL* SS
3/16	840	740
1/4	1,400	1,280
5/16	1,960	1,800
3/8	2,880	2,400

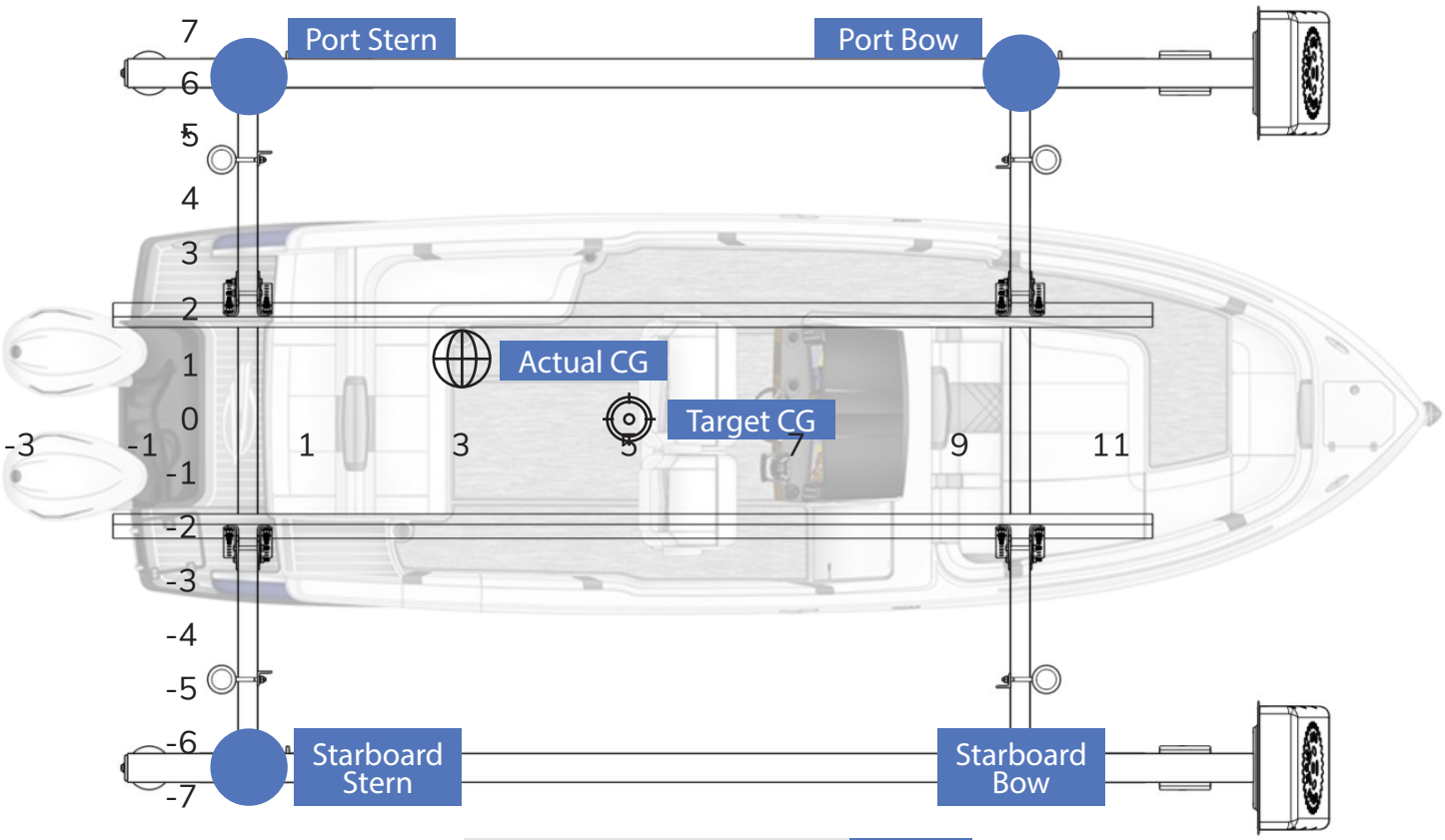
* With wire rope clips

Example

Taking our example 23' wake boat from Table 2 above, the Total Lifted Weight could be as high as 11,046 lbs for a 6,000 lb boat! We have to account for the worst-case-scenario of when the :

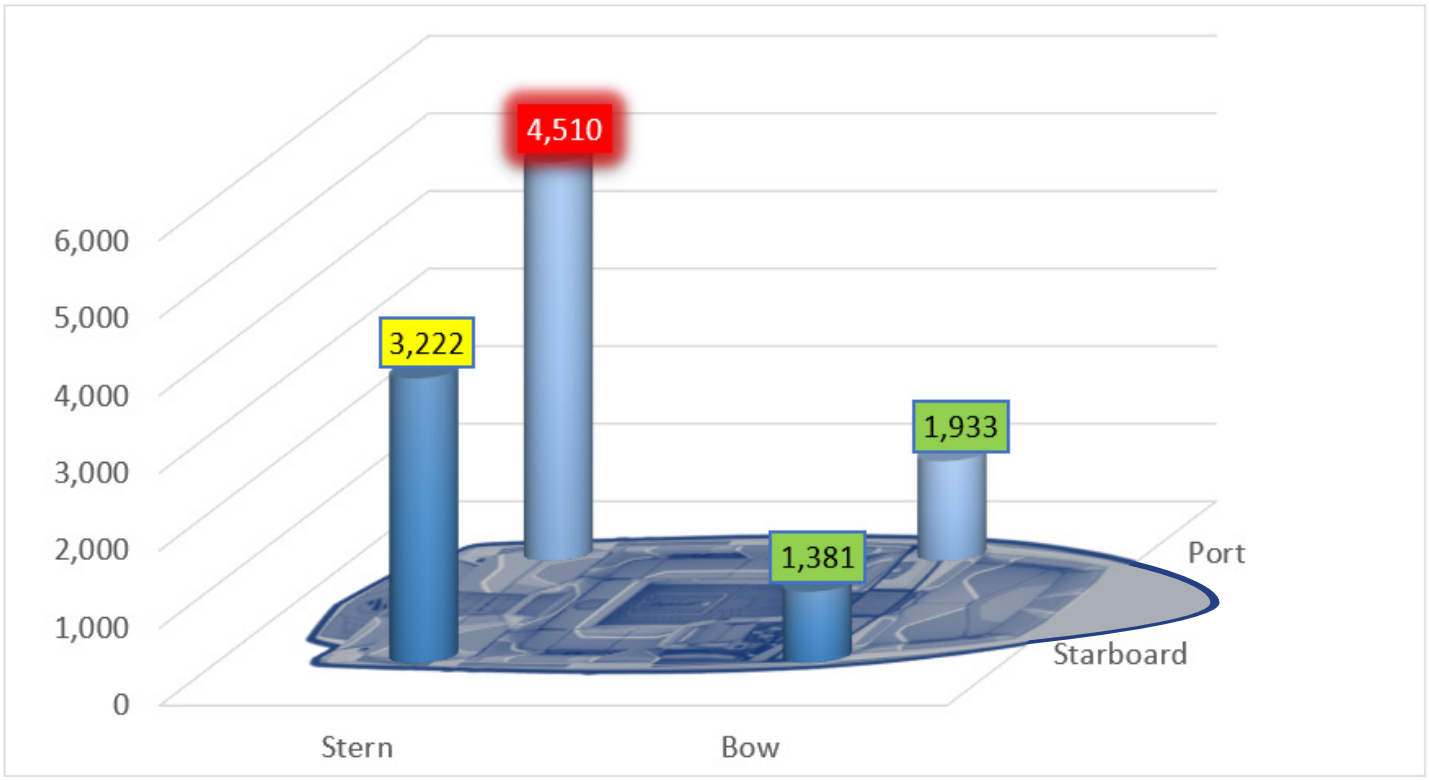
Boat Dry WT	6,000 LBS
Fuel WT	410 LBS
Water WT	4,087 LBS
Boat Wet WT*	**10,496 LBS**
Cargo WT	250 LBS
Cradle & Bunk WT	300 LBS
Total Lifted Weight	**11,046 LBS**

For this example, we will assume the CG of the loaded boat is located 7 ft in front of the stern which is positioned on the bunks 3 ft from the rear cradle beam. Additionally, the CG is located 1 ft port of centerline. The cradle beams are 10 ft apart and the lifting points on the cradle beams are 12 ft apart.



Dist. Between Cradle Beams	**10 ft**
Length of Cradle Beams	**12 ft**
CG distance fwd of cradle beam	**3 ft**
CG distance port of centerline	**1 ft**

With the CG at this location and for this "wet" boat weight, the picture below shows the tension in each vertical wire rope.



Reactions (lbs)

	Stern	Bow	Total
Port	4,510	1,933	6,444
Starboard	3,222	1,381	4,603
Total	**7,732**	**3,314**	
Ideal Weight/Line	**2,762**		

Additionally, assume the maximum angle of the cable from vertical is 15° due to the installation geometry. The reactions now become:

	Stern	Bow
Port	4,670	2,001
Starboard	3,335	1,429

Wire Rope Dia.	SWL* Galv. Steel	SWL* SS
3/16	840	740
1/4	1,400	1,280
5/16	1,960	1,800
3/8	2,880	2,400

Assume our example installation uses wire rope clips for the end termination on the Port Stern and we would like to use SS cable. We must compare the reaction load to the SWL of the cables from Table 3 above. Since the reaction of **4,670 lbs** exceeds the capacity of all the wire ropes offered, the lift is not capable of safely lifting the boat with a single line and must therefore be compounded. This lowers the tension in the cable by 1/2 to 2,335 lbs.

Wire Rope Dia.	SWL* Galv. Steel	SWL* SS
3/16	840	740
1/4	1,400	1,280
5/16	1,960	1,800
3/8	2,880	2,400

4,670 / 2 = 2,335 lbs

* Includes wire rope clips

This installation would require a compounded 3/8" SS cable if there was no other way to position the boat in the cradle.

BUT WAIT!!!! THIS SIZE CABLE IS TOO LARGE

This example shows what happens when a boat is placed incorrectly on the cradle. If we can ensure the boat is placed within ±1 ft of the ideal CG location, then the tension in each cable gets much better. If we re-run the calculation with the CG located 4 ft forward of the aft cradle beam and on the centerline, the highest load become 3,431 lbs.

Dist. Between Cradle Beams	**10 ft**
Length of Cradle Beams	**12 ft**
CG distance fwd of cradle beam	**3 ft**
CG distance port of centerline	**1 ft**

	Stern	Bow
Port	4,670	2,001
Starboard	3,335	1,429

Wire Rope Dia.	SWL* Galv. Steel	SWL* SS
3/16	840	740
1/4	1,400	1,280
5/16	1,960	1,800
3/8	2,880	2,400

3,431 / 2 = 1,715

This will allow you to use a 5/16" SS compounded cable.

If the boat were accidentally placed too far back in the cradle, we would simply be using up the safety factor built into the system. This is why wire ropes are not sized using the breaking strength.

Recommended Cable Sizes

BH-USA recommends the following cable sizes and configurations for the following boat weights using either galvanized or SS lines.

Lift	1 Part Straight Line	2 Part Com-pounded
2,800 lbs.	3/16	3/16
4,500 lbs.	1/4	3/16
6,000 lbs.	5/16	1/4
10,000 lbs.	x	1/4
13,000 lbs.	x	5/16
16,000 lbs.	x	3/8
24,000 lbs.	x	3/8*

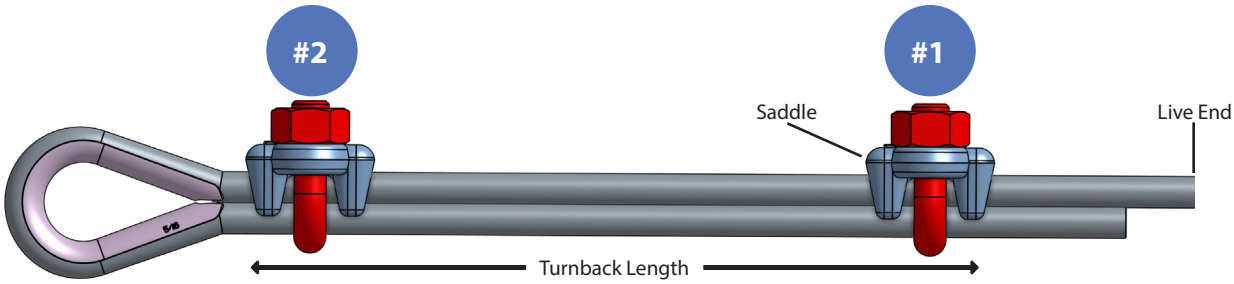
* with reduced SF

** Assuming proper boat loading on lift

Wire Rope Clips

It is important to install wire rope clips correctly to achieve the maximum holding strength of the connection.

- The wire rope clip saddles must be in contact with the live end of the cable. Remember…"Never saddle a dead horse"
- 3/16" to 3/8" wire rope requires the use of 2 wire rope clips.
- Pull the following amount of cable past the thimble called the turn back length before installing clip #1.
- Install clip #2 close enough to the loop to close the wire rope around the thimble.
- Tighten the fasteners to the recommended torque.
- Over tightening can damage the wire rope.
- Under tightening can cause the wire rope to slip through the clips and drop the load.



Wire Rope Dia.	Turnback Length (IN)	Fastener Torque (ft lb)
3/16	3-3/4	7.5
1/4	4-3/4	15
5/16	5-1/4	30
3/8	6-1/2	45

Spooling

When spooling the wire rope on to the drive pipe, it is important to take the following precautions: ▸ Take precautions not to permanently kink the cable.

- Unspool directly off the spool provided or lay the cable out straight to remove any twist before spooling on the boat lift.
- Keep the wire rope clean during installation. Grains of sand embedded in the wire rope will cause the wires to break prematurely.
- It is important the cable has tension on it when first spooling to keep the spooled cable tight and uniform on the drive pipe. It is recommended to have 1%-2% of the cable breaking strength on the cable as pre-tension.

It may be necessary to use cable weights to maintain tension. Lead cable weights are to be used on boat slings to maintain tension.

Additionally, it is possible for wooden bunks to float aluminum cradle beams causing the cables to lose tension when the cradle is lowered into the water. In this case, it is necessary to add weight to the aluminum cradle beam by drilling a hole in web of the beam and bolting the cable weight directly onto the beam.

Final Checks

After final installation, it is recommended to check the CG location of the boat on the cradle by means of a wire rope tension testing gauge. A recommended gauge is the Loos & Co Model PT-2 or PT-3 depending on the expected tension range of the cable.

1. Measure the tension in each cable
2. Add the measurements together and divide by the number of cables to get the Equal Weight per Line.
3. Reposition the boat toward the cables with lower tension to equalize.
4. Repeat cable tension measurements and positioning until tension in each cable is within 10% of each other.
5. If the cable tension cannot be equalized, ensure the highest tensioned cables are within the specified Safe Working Load of the size cable installed.

Wire Rope Inspection and Failure

It is important to frequently inspect wire rope for damage or wear. The following items will

Corrosion

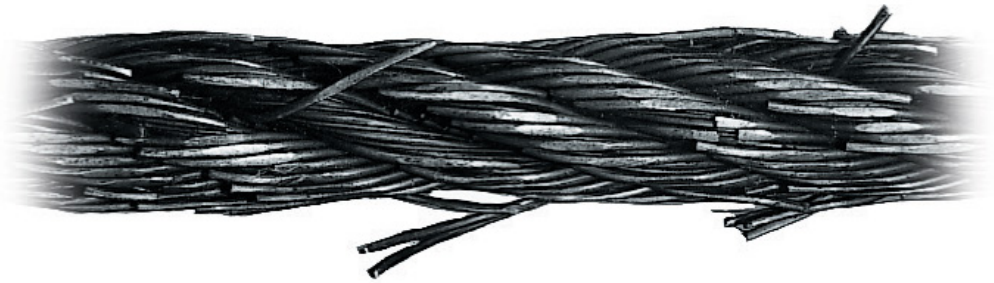
Both stainless steel and galvanized wire rope will corrode or rust over time. Rust will eat through the wires and reduce the capacity of each strand by creating a weak spot. It is recommended to apply a light coat of oil to the cable to prevent corrosion.

Wear

Wire rope will wear as it passes through sheaves and wraps around the drive pipe. It is recommended to apply a light coat of grease to the cable where it wraps around the drive pipe.

Fatigue

Fatigue damage appears as whiskers on the wire rope as the wire breaks due to the wire rope being repeatedly bent and straightened such as winding around the drive pipe or passing over sheaves. It is recommended to replace the wire rope as broken wires begin to appear.



Kinks

Permanent kinks can be put in the wire rope during installation if the wire rope is bent too tightly.

No product can operate indefinitely at its rated capacity. Wire rope and Cable must be inspected regularly for any deterioration which may result in the loss of original strength. User must determine whether further use of the rope would constitute a safety hazard to life or property. Lubricate operating ropes regularly. Keep out from under any raised loads and keep out of the line of force of any load. AVOID SHOCK LOADS. Due to the uncontrollable situations in which this cable is used after the purchase, BH-USA cannot warranty or be held liable for cable past the purchase date. It is the responsibility of the ultimate user to determine a working load limit for each application. Many factors should be considered: included among, but not limited to, loads applied, speed of operation, acceleration or deceleration, length of rope or cable, shock loads, abrasion, corrosion, number, size, condition and location of drums and sheaves, facilities for inspection, and the danger to life and property should a rope or cable break. Wire Ropes and Cables must be stored, used, lubricated and maintained in accordance with normal safety standards; and must be properly designed, maintained, and operated. Inspect regularly. Do not kink, knot or crush. Do not ever use wire rope sold by or made by BH-USA to lift humans in any way.

CAUTION!

BOAT LIFT CABLE is NOT for LIFTING HUMAN BEINGS it is only for LIFTING BOATS DO NOT RIDE THE BOAT LIFT

MOTOR/LIFT MUST BE PROPERLY GROUNDED
& MUST MEET ALL APPLICABLE ELECTRICAL CODES ALL ELECTRICAL COMPONENTS TO BE INSTALLED OR CHECKED APPROVED BY LICENSED ELECTRICIAN READ GUIDE BEFORE INSTALLATION AND USE.

CONTACT US!

800-259-8715
Monday - Friday
8 AM TO 5 PM *CST*

WWW.BH-USA.COM

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