

WHOI TowCam Safety Procedures

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Summary

The WHOI TowCam systems (Figure 1A-B) are normally towed from the UNOLS standard .0322" diameter coaxial cable that has been a standard cable for CTD use in the oceanographic community for decades. The breaking strength of this cable is 11,600 lbs. Several operational practices are geared towards ensuring the safe deployment and use of the TowCam while in operation. Briefly summarized they include:

- 1) The TowCam is always deployed using several safety lines to prevent swinging when over-boarding or recovering the system. The ship's Bosun or Shipboard Tech. are usually involved in the launch/recovery operations along with at least 3 trained members of the science party to handle the tag lines. Two restraining lines are used at all times to keep the system from swinging.
- 2) The TowCam is towed at very modest speeds, usually <1/2 kt (15 m per minute) and at distances above the seafloor of ~3-7 m, which are monitored on a second by second basis using the altimeter system on the CTD that reads out in real time in the ship's laboratory. A forward-looking altimeter provides 1 Hz update of large features in front of the system as it is being towed, so that collisions can be avoided and the system can be towed while ascending scarps of 10-30 m relief while still keeping the system ~ 5 m above the seafloor.
- 3) The TowCam is towed over seafloor only when there is detailed, multibeam bathymetry to that the general bottom characteristics and slopes are known and can be factored into the plan for the photo-traverse.
- 4) The TowCam is attached to the CTD seacable using a safety 'weak-link' (Figure 1C-D) that will help ensure that the yield strength of the cable is not exceeded so that it is not damaged if the system is hung up, and that the TowCam is recovered if it gets hung-up on the seafloor and the cable breaks.

The present applicable policies for WHOI ships are in the WHOI Management System Manual, part 7.9.2 Overboarding Operations, section 3 (Procedures), part D (Special situations), paragraphs 5 and 6, updated April 15, 2002.

(http://www.whoi.edu/marops/port_office/smm/07.9.2%20Overboarding%20Operations.doc)

CTD Cable Information

The 2% elongation point is not specified on the WHOI site, however, tests that M. Swartz of WHOI, PO Dept. conducted on this cable with the WHOI Rigging shop pull-test machine in the mid-1990s showed measurable elongation and internal conductor failure occurred in over 50% of multiple samples (n = 10 samples) at 9,500 lbs, +/- 500 lbs, or just above 80% of the final breaking strength.

The manufacturer's specified Safe Working Load for the cable is now 4,500 lbs. The manufacturer's specification is that the wire weighs 462 lbs per 1,000 meters in seawater.

Each WHOI TowCam is equipped with a 'safety weak-link release' that is a simple bolt-shear device consisting of a 'tongue and groove' stainless steel block with a machined hole in the middle of the block that contains a bolt of known breaking strength that holds the two pieces together (see Figure 1D). Traditionally, when operating at ~2000-3000 m depth (normal mid-ocean ridge crest depths), the breaking strength of the bolt in the weak-link has been rated at 4,500 lbs. The weak-link is shackled between the normal cable termination and the tow point on the TowCam frame (Figure 1D). The standard WHOI cerrobend-potted CTD termination is used for the Towcam. This termination with a 1/2"SS bolt has been tested in the WHOI pull-test machine and found not to deform even when the wire was pulled to breaking point, which occurred at 11,500 lbs, +/- 500 lbs.

Since the mid-1990s, WHOI has used a safety link, consisting of a "Chinese finger" (see Figure 1C-D) of either galvanized steel or aramid fiber, wrapped to the cable at least 0.5 meters above the termination, and attached securely to the frame below with heavy plastic coated mooring wire. The galvanized Chinese finger from the manufacturer has been tested in the WHOI pull-test machine and found to hold the wire up to the breaking strength of the wire. Because of the design of the Chinese finger, the tension is nearly evenly transferred along the wrapped length of the Chinese finger to the cable, and thus minimizes areas of high strain. When the wire failed, it did not fail within or at the end of the Chinese finger.

When the weak-link bolt shears (when pulled to tension greater than 5,000 lbs), the main termination would give way, and the TowCam would then be tethered to the cable by the Chinese finger and a shot of steel mooring cable, secured to the aft end of the TowCam. This would have the effect of lifting the aft end of the frame, thereby tilting it away from the outcrop. All the components of this safety link have either been tested or are certified to have a safe working load (SWL) in excess of 11,600 lbs, which is the tension at which the 0.322" CTD cable will part.

For example, when operating at 2000 meters, with approximately that amount of meters wire out, there would be about 920 to 1000 lbs static load at the sheave due solely to the weight of the wire. Add to that the weight of the TowCam in seawater which is ~800 lbs, and an approximate value for drag from ship motion and water entrapment in the sled when the ship is heaving, and this can provide up to 500 lbs or more of variation in the steady state load. Therefore, tension at the termination, when the TowCam is deployed at ~2000 m depth, would be in the neighborhood of 1720 to 2320 lbs- much less than the currently used 5,000 lb rating for the weak-link and substantially less than the breaking point of the cable.

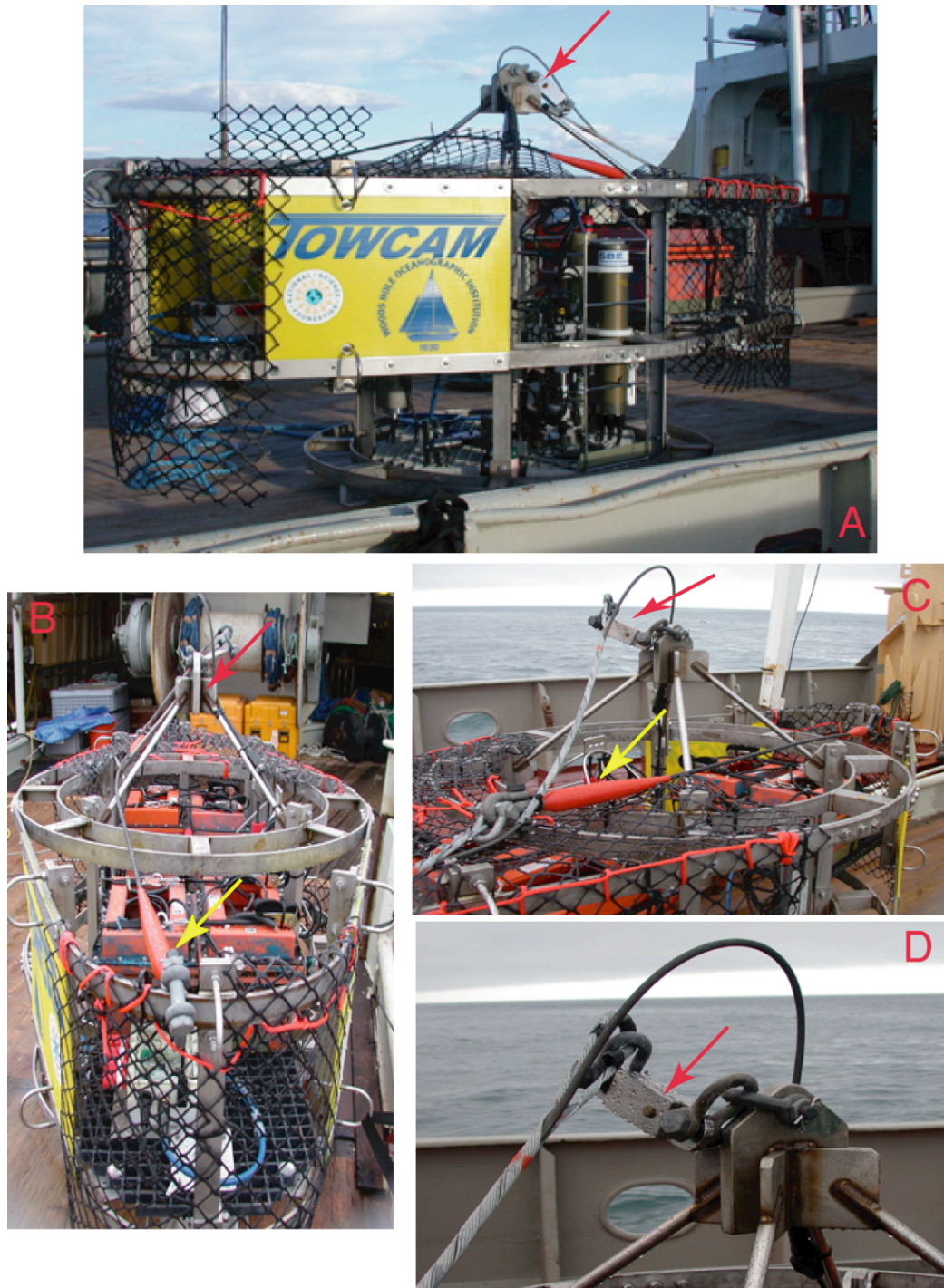


Figure 1. A) Overall view of WHOI TowCam#2 system. Red arrow points to the weak link (see photos C and D). B) View from the rear of the TowCam showing the attachment point of the safety cable (yellow arrow) to the frame, and the red arrow shows the towpoint where the weak link is attached to. C) Top of TowCam#2 showing safety cable (yellow arrow) and weak link (red arrow). D) Red arrow points to the weak link; connected to the TowCam frame by a shackle (right) and the eye on the 'Chinese-finger' (left). The Chinese-finger is the silver colored braiding wrapped over the sea cable (dark gray loop above red arrow).