

Tether Management System

In March 1995, Harbor Branch Oceanographic Institution successfully completed sea trials of our tether management system for use in support of our series of ROV based manned submersible rescue systems. The TMS is purpose built for the HBOI Rescue ROV “Panther” which is 25 HP, weighs 2,000 lbs., and has dimensions of 41”W X 42.5”H X 66”L. The TMS and ROV systems have operated at sea from March 1995 to the present. This TMS is also capable of supporting most ROV’s in the 1000-4000 lb. range. What makes this TMS attractive is its small size (6 ft dia. X 64.5”H), its light weight (1450 in air), its low cost, its unique cable friendly sheaveless cable handling design, and the fact that power and control of the TMS functions only require three wires, 300 lb. line pull.

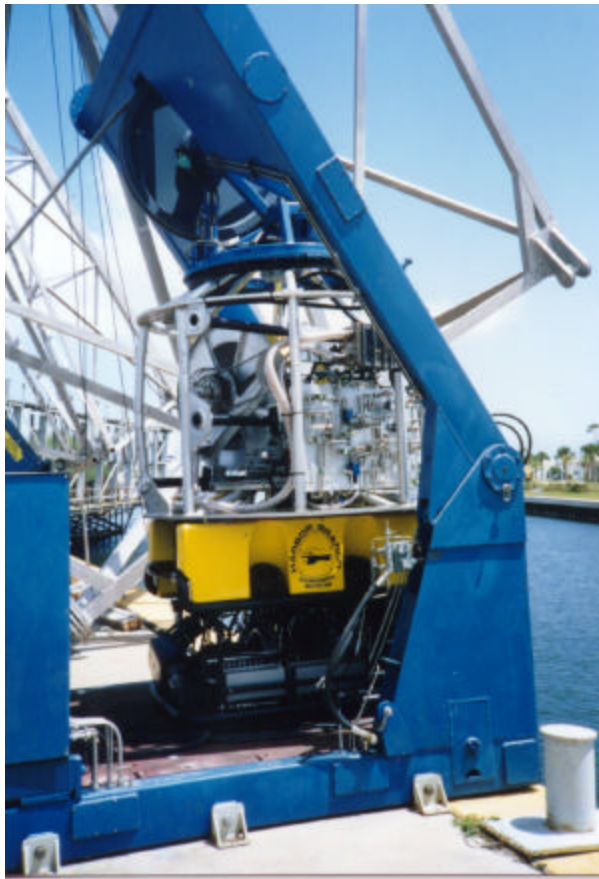
The HBOI TMS has several characteristics which make it unique.

The cable handling mechanics in this system are unlike most TMS units used today. Standard units use a number of sheaves and guides to bring the tether from the point it enters the TMS to the area where it is presented to the storage drum. Once the cable is at the drum, a level wind forces the cable back and forth along the drum as the drum turns. Typically, these sheaves and guides are considerably smaller in diameter than the minimum bend radius of the tether cable. Powering the tether through the series of guides and sheaves requires a lot of power. Most units power the drum for the tether in mode, pulling the tether through the sheaves and guides. As a result, only a fraction of the drum line pull is actually seen at the tether which is not an efficient method of providing tether in, especially when recovery of a dead vehicle is necessary. In the tether out mode, most TMS units use a powered sheave to pull the cable through the sheaves, guides, and off the drum. With this method, the powered sheaves are loading the tether over sheaves with too small a bend diameter, resulting in a reduced service life of the tether.

The HBOI TMS stores the tether on a horizontal drum with a core diameter of 28” as compared to as little as 16” on some units. As the tether enters the TMS, it is directly in line with the drum. No sheaves or guides are needed to bring it to the drum. As the drum turns, paying in or out cable, the tether travels straight down through the latch assembly and out of the TMS. As the drum turns, the mechanics of the TMS move the complete



drum assembly horizontally. For every revolution of the drum, the mechanics of the drum move it horizontally one cable diameter which ensures that the cable coming on/off the drum is lined up with the latch assembly and exit of the TMS. As the drum reaches one end it reverses direction and starts to pay in/out the next layer of cable. In the tether in mode, the drum pulls in cable directly from where it exits the TMS and through the latch assembly. As a result, all the line pull of the drum (winch) is available for recovery of the tether and ROV. In the tether out mode, the drum is also powered presenting cable through the latch assembly and TMS cable exit. To ensure the tether is always stored neatly on the drum and under a small amount of tension, a set of rollers is used. The tether passes straight through these rollers so that the cable does not see any bending. A small amount of compression against the tether is maintained on the rollers by a spring. The rollers are mechanically coupled to a hydraulic motor.



During tether in, the drum is pulling the tether through the rollers. Since the rollers are in compression on the tether, the cable drives the rollers, which in turn causes hydraulic fluid to move through the motor.

The fluid flow is limited by a relief valve. The resistance in fluid flow puts a resistance on the rollers, thereby maintaining tension on the tether. In the tether out mode, the rollers are driven by the hydraulic motor. The motor torque and speed are limited to ensure that it can not pull cable off the drum. As the drum pays out cable, it hands it to the rollers which keep it in tension and force it through the latch assembly and the TMS cable exit. As a result, the cable handling mechanics are very tether friendly and provide longer tether service life and less down time. The direct pull of the drum develops 300 lbs. of line pull from a 5 HP hydraulic system.

The electro-hydraulic system differs from most also. The typical TMS/Launcher hydraulic system has a three phase electric motor (three wires) driving a hydraulic pump. This motor is running continuously while the ROV is released from the TMS. The pump supplies flow to solenoid valves, one for selection of tether in/out, and at least one more for latch/unlatch of the ROV from the TMS. The solenoid valves require control by either hardwire from the surface (3 to 6 wires), or a TMS telemetry system.

The HBOI TMS uses the phase rotation of the electric motor, the motor direction clockwise or counter clockwise, to control tether in/out and the vehicle latches. This method only requires the three wires which drive the motor. No solenoid valves or control wires are needed. The motor only operates when it is doing work and remains off unless tethering in or out. This is accomplished by

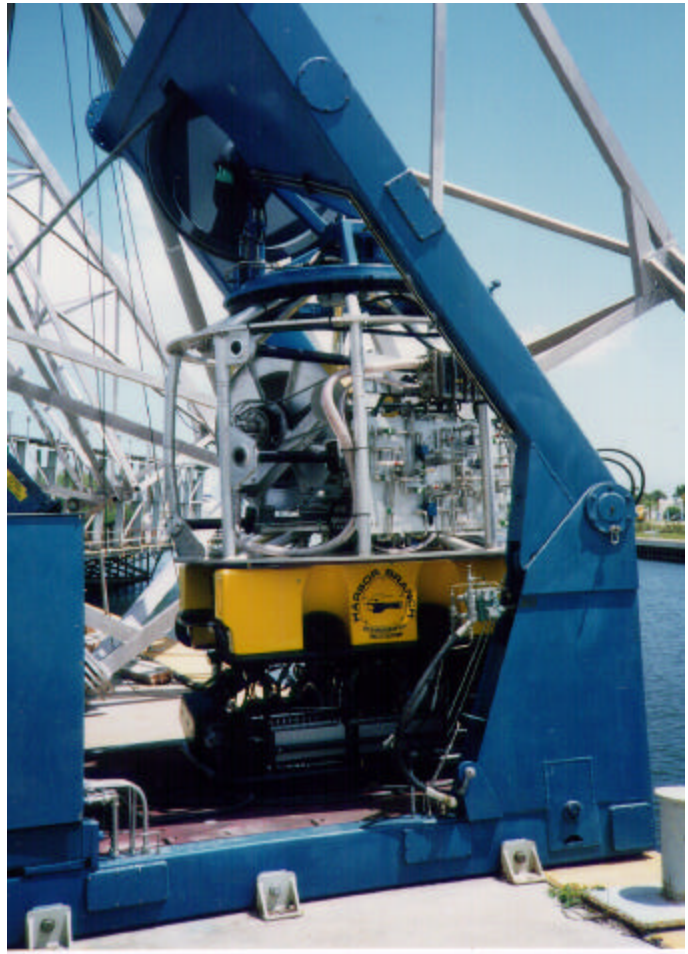
using a reversing contactor (instead of a standard contactor) on the surface. When the pilot commands tether out, the contactor turns the motor clockwise. When the pilot commands tether in, the contactor reverses the phases to the motor and turns on the motor counter clockwise. As the pressure and suction/return side of the TMS hydraulic pump reverse with the motor direction, the path of hydraulic flow changes through the hydraulic circuit. Flow in one direction opens the vehicle latches and pays out tether. Flow in the other direction pulls in tether and closes the latches.

The shape of the latches and the lift/latch point on the ROV allow the ROV latch point to be pulled past the TMS latches to dock the ROV. Springs on the TMS latches stop the latch dogs from releasing the ROV. In addition, the shape of the latch dogs, the shape of the ROV latch point, and the position of the latch dog pivot point ensure that as the downward force on the latches increases, the latches pull in (engage).

The TMS presently supports a minimum of 400 feet of 1.15” diameter tether cable. Tethers of other diameters and lengths can be accommodated by changing one or more of the drum dimensions, such as flange diameter, core diameter, drum width, and/or height.

If a typical hydraulic system is desired, for example, a standard motor/pump powering solenoid valves, the mechanics of the TMS will directly adapt to such a configuration.

Depending on the number of conductors or telemetry available, additional functions of the TMS can be configured in a number of ways. The existing HBOI TMS has the following features—a TMS camera (running on a hard wire coax to the surface), a cage light with fully variable intensity (using two 18 awg wires to the surface), three sensors to detect when the ROV is completely engaged in the latches (one 18 awg to the surface), a tether counter which reads out in feet not revolutions (one 18 awg to topside), a common ground for the above items (one 18 awg), and a hardwire responder for the acoustic tracking systems (1 TSP).



Harbor Branch Oceanographic Inst.
Tether Management System Specifications

- A. Dimensions - Six foot diameter x 64.5 inches high
- B. Weight- 1500 pounds; additional weight may be added as ballast
- C. Electro Hydraulic System
 - 1. Five horsepower (three phase 575 volt 20-28 amp)
 - 2. 2,650 PSI
 - 3. 2.4 GPM
- D. Winch/drum
 - 1. Line pull is 300 pounds
 - 2. Line speed is 100 feet per minute
- E. Cable capacity - Present configuration supports 400 feet of 1.15 inch diameter tether cable
- F. Depth rating - Since the system is pressure compensated, the depth is only limited by the interface cables selected and any camera or lights used.
- G. Docking System- incorporates three hydraulically operated latches
- H. Materials-
 - 1. The frame, drum, and carriage assembly are constructed of 6061-T6 aluminum
 - 2. All of the hydraulic tubing and fittings, components of the latch assembly, the diamond screw, etc. are 316- stainless steel.
 - 3. Where feasible, ultra high molecular weight polyethylene, Delrin, PVC, and acrylics are used.
 - 4. To avoid contact between dissimilar metals, where possible plastic (Delrin or PVC) insulators are used.
- I. Video/lighting and Instrumentation - the current configuration consists of:
 - 1. Low light C.C.D. wide angle camera (Photosea TV-1200)
 - 2. Fully variable intensity (0-250 watts), adjustable beam angle light, (ROS Mini Versabeam).
 - 3. A tether payout counter, which reads in feet
 - 4. Vehicle docking sensors, three each, which detect when each latch has engaged the ROV.
 - 5. Transponder/Responder acoustic beacon (ORE 4320)

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