CRUISE REPORT

U-TOW TESTING
NOAA Ship MILLER FREEMAN
11 Nov. – 14 Nov. 2004

A U-Tow cruise was scheduled to introduce the system to PMEL/FOCI employees and to certify that the system met the terms and specification of the initial contract.

The head of Envirotech (Mark Rawlinson) Wm Floering and Sigrid Salo boarded NOAA Ship *Miller Freeman* in Astoria on Nov. 11th, 2004. While setting up the U-Tow system, a discrepancy was found in the total resistance of the U-Tow system. After a few hours of testing it was determined that the resistance was in the cable, not in the U-Tow vehicle, junction boxes or the slip ring assembly. The high resistance (58 ohms) caused the line voltage to drop below the point necessary to wake up and power the U-Tow computer.

Mark and Sigrid drove to Seattle late on the 11th; Wm. Floering remained on *Miller Freeman* for the trip to Seattle. Based on Mark's recommendations, Floering and the Freeman ET did some additional testing and added another wire to the power side of the connection. The potted termination was made in anticipation of towing the vehicle on Sat.

Mark, Sigrid and Earl Roskie boarded NOAA Ship *Miller Freeman* at Shilshole marina on Sat. Nov. 13th. We spent the day checking wires, testing the system and trying to overcome the higher than expected wire resistance. The solution that worked best was to attach 3 of the 7 conductors to the power side of the U-Tow deck set; the system ground wire was attached to the cable shield leaving 2 wires for U-Tow communications and two wires for the LOPC communications. After these connections were made the termination was again potted and allowed to cure overnight.

On Sunday Nov. 14th 11 people from PMEL and Fisheries boarded *Miller Freeman* at Shilshole marina. A number of test tows were completed towing north from Shilshole marina. People had the opportunity to interact with Mark and see how the systems performed during the test tows. The U-Tow system performed flawlessly when towed at 6 knots. When the tow speed was increased to 10 knots the real time data window would lock up for a brief time, attempt to catch up and lock again…..No doubt some data was being lost at this towing speed. It appears the problem is in the cable, additional testing will be required to locate the exact cause of the dropped data packets.

In addition to the test tows, the U-Tow was lowered vertically to 200 meters to check the integrity of the pressure cans. Everything performed as it should at this depth and with no additional towing strain on the cable no data was lost during this test.

The testing phase of this cruise was completed at 7pm on Sunday Nov. 14th. The scientific personnel disembarked at the Shilshole marina and *Miller Freeman* steamed through the Ballard locks to PMC.

On Monday Nov. 15th a debriefing was held in room 1023 of Building 3. It was agreed upon to look further into the wire resistance and dropped data problems (see below). Additional modifications to the U-Tow were discussed. Mark is going to modify the nose cone to accept the TAPS system and build undercarriage bars with a new bottom mounting plate for additional sensors. These two items will be available for *Miller Freeman*'s sea trials late January.

Since the meeting on the 15th, I have received some addition information on the tow cable. The wire manufacturer (Rochester) states that the nominal resistance of this cable is 16 to 16.3 ohm per 1000 feet of cable. We have 3500 feet of wire on the drum so a total resistance of 58 ohms is within specification. The total wire resistance could be cut in half by reducing the cable length to 550 meters. This would create an additional problem because this shared cable is also used to tow the MOCNESS and on occasion they deploy 800-900 meters of wire during a tow. The cause for the lost data when the tow cable is under a strain has not been determined. Additional testing will take place on *Miller Freeman* pierside the last week of Nov.

In addition to this report see the attached recommendations presented by Mark Rawlinson.

Wm. Floering
William.floering@noaa.gov
206-526-6480

EnviroTech LLC
1517 Technology Drive, Suite 101
Chesapeake, VA 23320, USA

Commissioning Report

NOAA/PMEL - U-Tow System

15 November 2004

Mark Rawlinson

Introduction

A U-Tow system undulating towed vehicle system was installed aboard the NOAA vessel Miller Freeman during the period 11 – 14 November 2004.

The system comprises:

1. U-Tow vehicle system
2. LOPC system (NOAA supplied)
3. Sensors (NOAA supplied)
4. Tow-cable (NOAA supplied)
5. Winch with slip-rings (NOAA supplied)
6. PC (NOAA supplied)
7. Ocean Windows software

Narrative

The U-Tow system was loaded in Astoria, OR on 11 November. The cable from tow vehicle to Data Plot Room (DPR) was found to have unexpectedly high impedance. This caused the voltage drop along the cable to be excessive and limit the power delivery to the tow vehicle. The on-board cable run (from the winch to the DPR) was eliminated as the problem – being relatively low impedance – but this was as far as trouble-shooting could progress on 11 November due to time constraints. On 12 November Bill Floering and the Miller Freeman's ET established that the slip-rings were also low impedance and the cable alone was providing the excess resistance. On advice from the manufacturer NOAA personnel attempted to resolve the issue by ganging a spare conductor in the cable with the positive supply conductor to reduce impedance. This improved the situation marginally, but did not resolve it fully.

On 13 November the cable was re-wired once more, this time ganging three conductors for the positive supply and using the cable armour as the ground / return connection. The impedance was reduced from the original 112 ohms to 21 ohms by these measures. This "fix" appeared to resolve the problem and the entire system was tested on deck. The new termination was encapsulated and left to cure overnight.

It should be noted that the cable termination method is not ideal due to the dual use of the cable & winch between U-Tow and another towed system (MOCNESS). At present the cable must be cut and re-terminated each time one of the two systems is used. Also as the termination is done "at sea" it is not feasible to implement the recommended water-blocked termination. This is likely to lead to other (separate) cable problems in the future.

The system was tested at sea on 14 November. Several tow tracks of approximately 40 – 50 minutes duration were transited. Initially the LOPC was not fitted. On the first two tracks the U-Tow "flight" and control system was set-up and tested manually at a ship's speed of approximately 7 knots and cable length (paid-out) of up to 160 m. All systems operated normally and the vehicle responded well to manual commands, with normal pitch and negligible roll.

On Track 3 the system was set to undulate automatically. After some minor adjustments the system undulated in a smooth double-arch pattern. U-Tow was recovered and the LOPC fitted and tested on-deck.

U-Tow was deployed and set to undulate in the same pattern as previously set. The vehicle responded normally with the only change being an approximately 2 degree roll due to frontal asymmetry of the LOPC. However, occasional communications problems were seen with the LOPC operating and the associated software system running on the same PC as Ocean Windows (U-Tow software). The two software packages appear to clash during certain communication operations. Temporarily shutting-down the LOPC software resolved the problem each time.

After successful undulations along one track the ship's speed was increased to 10 knots and the cable paid out to 200 m. At this point the system suffered erratic communications problems. Reducing the ship's speed (and therefore reducing the strain on the cable) to the speed of the initial tows resolved the problem. This was repeated twice more with the same problem each time. The problem could also be induced by making U-Tow dive and "dig-in" so increasing strain on the cable, even at shorter cable lengths. These experiments clearly demonstrated that with additional strain on the cable the electrical characteristics of the cable changed sufficiently to effect the system communications. This is highly unusual and indicative of a defective cable. This deduction is also supported by the original high impedance in the conductors.

The vessel proceeded to a point about half-way along the tow track where the water depth was approximately 220 m. At vessel dead-stop U-Tow was lowered to 200 m and left for a few minutes. All functions were normal throughout this test demonstrating the water-tight integrity of the system to 200 m and that with relatively low strain on the cable no communications problems were exhibited. This also probably eliminates specific damage to the cable section between 160 and 200 m.

Recommendations

1. Replace the tow cable
2. Implement a permanent water-blocked termination with adapter cables for each of the two towed systems so that "at sea" termination can be avoided.
3. Move the LOCP software to a second PC to avoid resource clashes with Ocean Windows
4. Implement a desk top or rack mounted PC for Ocean Windows with (or install) two "full" serial ports for vehicle communications and GPS (possibly also with a removable hard drive for easy data porting)
5. Consider new dedicated winch & cable for U-Tow
6. Consider fairings
7. Consider lower frame for mounting LOPC (and other instrumentation)