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

**Commissioning Report**

# NOAA/PMEL - U-Tow System

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**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)