RE-USE AND RE-ROUTING OF RETIRING SYSTEMS

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Abstract: Over the last few years there has been an increasing interest in recycling the components of retiring systems, to provide telecom traffic over a new route. As these new routes may not warrant the cost of purchasing a completely new system, the recovery and re-installation of a retiring system may provide a more cost effective solution. The challenges of recovery and relaying a retiring system along a new route are discussed. The associated testing and commissioning requirements are also examined. Whilst the standard system life design is for 25 years, other equipment and software has a shorter life, as such, re-engineering maybe required to replace obsolete equipment. The consequences of dismantling and the reassembly of equipment are considered. Operation and Maintenance of re-furbished systems is an important consideration as skilled people are required for installation, testing and training. Finally, the parameters and conditions required from both the donor system and new route are discussed so that any future system-recycling program can be evaluated objectively.

1 INTRODUCTION

The recovery and re-laying of cable is not a new concept, however, it is rare. Over the last few years there has been increased interest in how to utilise valuable seabed and terminal station assets that have not reached the end of their design or useful life.

It is not uncommon for cable vessels to recover long lengths of cable. Many old systems have been recovered either to: -

- reclaim seabed space for a new system
- for the scrap value content, such as copper and polyethylene
- comply with any original or new permit conditions
- avoid any liabilities from other seabed users.

However, this form of recovery does not need the care and attention required to ensure the recovered cable is of sound quality for re-use in a new system. When recycling systems, the main objective is to ensure that none of the recovered cable is subjected to forces that exceed its design parameters. Such assurances are critical to give the client confidence of success.

PacRimWest (PRW) was installed in 1994 and retired from active service in 2004. Although in service for only 10 years, PRW was designed to last for 25 years, and was thus technically capable of a further 15 years service. The Australia to Papua New Guinea (APNG-2) system purchasers, Telikom PNG, Telstra & Telecom NZ commissioned studies, which concluded that the PRW cable system would be an ideal system donor for recovery and re-installation along a new route.

2 PROJECT PLANNING

All projects require thorough project planning, and the recycling of installed systems is no exception. In this instance, approximately 1700km of the existing cable would need to be recovered and re-laid to a new landing in Port Moresby, Papua New Guinea [figure 1]; a shore end cable section would need to be formed from existing spare cable; and a terminal station would have to be dismantled and re-installed.

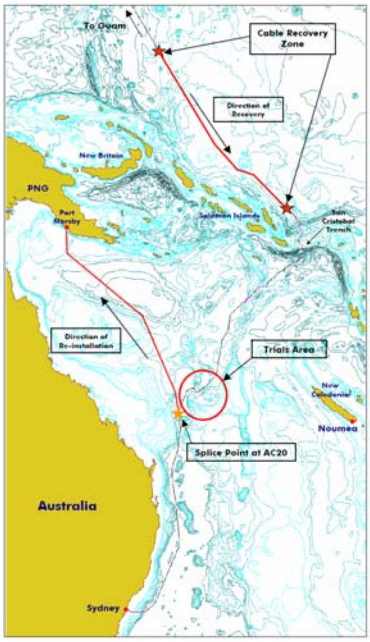

Figure 1: Overview Map

To recover this length of cable it was necessary to consider, and understand, a number of additional factors:

- Quality of the recovered cable
- Yield of usable cable recovered
- Cable Tension during recovery (directly related to speed of recovery)
- On-board cable handling limitations
- System performance

Of the above factors, it is clear that one is paramount to the success of the remaining four. Cable tension must be properly controlled during cable recovery, as this will determine the achievement of good cable quality, yield, handling and performance.

3 CABLE TENSION CONTROL

Whilst optical and electrical testing is the main check for integrity of the system, it is important to monitor and record the cable tension during recovery to make certain the cable does not exceed its design parameters. Cable tension provides confidence that the cable has been handled correctly and removes any uncertainty of long-term damage either externally or internally.

The cable recovery operations for APNG2 were generally from water depths of 3000 metres. Based on the OALC2 (21.5mm slotted core) cable design, and assuming wave heights of 4 metres (which are not uncommon), and an 80° angle of cable at the sheave, a recovery speed of 1.62 knots should theoretically be possible to maintain the recovery tension at 48kN for LW cable and 56kN for LWP cable, without repeaters within the water column.

Greater consideration to cable tension is needed when a repeater comes on-board. During the over-sheaving of a repeater, the cable tension increases and therefore it is essential to reduce recovery speeds before it arrives at sheave in order to maintain tension within the cable design parameters. The tension increase is more evident with older style repeaters, such as those on PRW, as they often have higher magnification factors than modern repeaters. These PRW repeaters weigh 390kg in air and 215kg in water, so, during recovery under the same conditions, we expected there to be an additional tension on the cable of approximately 4kN

For the recovery operation of the PRW donor cable, it was recommended to stay within cable tensions of less than 45-50kN, so that any tension spikes, due to sudden vessel motion, would remain inside the cable design parameters (the fibre slack cancelling load).

However, depending on actual sea state, actual cable lead angle, ship motion and water depth it was possible that higher recovery speeds could be achieved whilst keeping recovery tension less than 50kN.

It should be noted that the recovered portion of PRW was all in deep water of more than 2000m, and as such tension control was the primary driving factor for the operation. In shallower waters, i.e. less than 1000m, the cable is generally armoured and often buried, so other factors may affect cable tension during recovery. The "peeling" of the cable out of the seabed may have an effect on the tension and therefore also the recovery progress. So too may the seabed type and the original burial method (plough, ROV, trenching etc). Stable cable tensions may not, therefore, be achievable when recovering buried cables. Such tension fluctuations could potentially damage the cable, resulting in a low yield rate, more cable joints and increased project duration.

4 CABLE TRIALS

The theory of maintaining cable tension is relatively straightforward, however the other factors of cable quality, yield, handling and performance cannot be so easily quantified by theory. Real data is required to provide any level of confidence in determining the viability of the cable recovery project. The cable trial's primary aim was to give confidence that the cable quality, yield rate, handling and performance were at such a level that there could be no doubt on the viability of the project. The results of the trials, in particular the recovery speed, also allowed overall project timescales to be finalised.

In May 2006, the ASN cable maintenance vessel, Ile de Ré, left her homeport to commence the cable recovery trials of 340km of Light Weight (LW) cable, plus three repeaters, in water depths up to 3500m. Recovering cable from these depths is not new as maintenance vessels are equipped to replace sub-sea plant (amplifiers, branching units) from such depths. However, maintenance vessel's normal activities only require short lengths of cable to be coiled in to the cable tanks. The quantity of cable to be recovered for APNG-2 required additional personnel to be employed to coil the cable into the vessel cable tanks for extended periods (i.e. more than 3 weeks).

Figure 2: Recovered Repeaters

The APNG-2 cable trials were a resounding success. The quality, yield, handling and performance of the recovered cable far exceeded expectations. During the trial, average recovery speeds of 1.3 to 1.8 knots (2.4 - 3.3km/h) were achieved and cable tensions were generally kept below 40kN. This allowed for tension spikes of 50kN, which was still below the cable design parameters. These speeds correlated extremely well to the pre-trial theoretical calculations.

During the trial, the Ile de Ré travelled astern whilst recovering the cable over the stern. For vessel handling and comfort, this was changed during the main project recovery program so that the vessel travelled forwards whilst still recovering cable over the stern.

The weather conditions during the trial were such that, for most of the time, the ship's heading was 80º to the cable route. The cable lead angle generally remained between 75º and 95º, with angle to port/starboard mainly zero.

It was observed that as a repeater or joint box lifted off the seabed there was minimal/zero change in cable tension. Therefore, to avoid a repeater appearing at sheave without prior warning, it was important to accurately record the cable length in order to anticipate the next repeater event. For each repeater sheave recovery the vessel speed was reduced to 0.3 knots (0.6km/h). Over the trial period, the average rate of recovery was about 2.5kmh, but on days when a repeater was recovered, the average rate dropped to 2.2kmh.

It is worth noting that, despite lying on the seabed for 10years, the recovered cable and repeaters were in pristine condition - almost as though straight from the factory [figure 2 and figure 3].

Figure 3: Recovered Cable

The trials demonstrated that, in this instance, the cable recovery/re-installion had high yield, good cable quality, stable system performance, and normal cable handling characteristics.

5 TESTING AND COMMISSION

Formal system tests were performed on both wet and dry plant to establish a base line reference point and assess system performance.

To undertake the project, we needed to employ people who had a detailed knowledge of PRW (a mono lambda system) and its parameters, so they could adapt old procedures to meet modern requirements and integrate old and new equipment. To augment the team, system engineers and technicians were specifically trained with the PRW technology. To support on site operations, office based engineers prepared documentation and procedures. To assist the client, they devised a training programme.

Whilst such supplementary training is unusual, and would not be required for a brand new system, it was essence to the success of this essential project, irrespective of the additional cost.

The initial task was to rigorously test all parts of the system from power feed to network management, plus spare cards and test equipment. This was exhaustive and allowed us to identify obsolete items and assess whether damaged items could be repaired. During the marine trials, transmission parameters and fibre behaviour were carefully tested and reference was made to the base line. The results were positive and gave further confidence that the project could proceed within the assessed risks.

The careful dismantling, packing and transportation of the Guam terminal station equipment was critical to the project. As such, special procedures were put in place to ensure the correct labelling of all parts and the precise reconstruction of the terminal equipment in Port Moresby. At this stage of the project, damage to any crucial parts may have led to significant delay or even failure. Whilst some repairs may have been possible, the complete manufacture of new equipment was not.

6 CABLE ENGINEERING

The new route was surveyed from Port Moresby to a point on the original PRW cable route. The survey was no different to any other cable system. During the survey some route development was performed to find a route that avoided the use of LWP in deep water. A route was defined and RPLs/SLDs agreed.

The main deep-water section for the APNG2 route was relatively straightforward to engineer, as much of the recovered PRW LW cable would be allocated to the new APNG-2 route. However, the route into Port Moresby required more thought in terms of armouring requirements. Much of the armoured cable was sourced from the existing PRW cable spares either already on-board the maintenance vessel or at the maintenance cable depot. These lengths of cable (Double Armour, Single Armour and Light Weight Protected) were joined together to create the required system structure for the shore end and shallow water section

To provide further cable contingency for the APNG-2 operations we considered recovering some armoured cable from the PRW system route on the approach to Guam. Unfortunately, several cables had been installed on top of the PRW cable, and had the armoured cable been recovered, it would have been in small cable sections. These would have needed to be joined together to create a usable length and it was decided that the amount of time involved and the number of cable joints required would not make this a cost effective solution.

7 CABLESHIP SELECTION

The Ile de Ré, based in Noumea (New Caledonia), is part of the Private Maintenance Asia Pacific fleet and was ideally suited for this project in terms of availability and capability.

The Ile de Ré is capable of recovering the entire 1700km length of PRW cable required for the new APNG-2 system. However, this would have resulted in “locking in” the maintenance cable spares on-board and would have jeopardised the ability of the Ile de Ré to uphold her primary function – that is to provide timely cable maintenance services in the region.

Dividing the APNG2 project into two recovery/re-lay phases allowed the Ile de Ré to remain ready for her cable maintenance duties and also allowed flexibility in the APNG2 relay. The two-phase operation also meant that, should the amount of donor cable being used vary from the original plan, some fine-tuning of the amount being recovered in Phase 2 could be made.

8 RECOVERY AND RE-LAY

All the system monitoring was performed from the Cableship during the recovery phase. After the cable trials the PRW system was left disconnected at the trial site, with sea earths installed on each end. This allowed the Sydney terminal station to monitor the repeaters that would become part of APNG-2, independently from the Cableship test operations.

Due to the polarity of the repeaters in the system, the direction of recovery also determined the direction of installation. PRW was recovered from north to south; therefore it had to be re-laid south to north in order to maintain the correct repeater powering polarity.

As determined from the trials, the ship recovered cable over the stern, and travelled ahead. However, when a repeater was to be recovered, the ship’s heading was changed such that she was travelling astern along the route. The cable lead angle generally remained between 60º and 80º, with angle port/starboard zero, but never more than 10º.

The average recovery speed was 3.08 kilometres per hour (km/h), however, it should be noted that the recovery speed is directly related to water depth and therefore cable tension and also whether a repeater was being recovered. Recovery rates of 4.4 km/h were achieved in water depths of 1700m, reducing to 2.2 km/h at depths of 4500m. When a repeater was boarded the speed generally reduced by up-to 1.0km/h.

9 CONCLUSION

The recovery and re-lay was a great success – 1700km of cable plus 13 repeaters and 23 joint boxes was recovered without cable or fibre break from water depths ranging from 5000m to 1600m. This gave a 100% yield on cable. Recovery speed was as predicted and the high quality of the recovered cable resulted in ease of cable handling. The donor cable recovery was unproblematic and the cable was re-installed on to featureless seabed.

APNG2 is a mono lambda system and the line design is less sophisticated than the new WDM cables. Our experience in this project suggests that recovery operations for these systems would also be possible.

Not every retiring cable system is a suitable candidate as a donor. Meticulous studies are required before embarking on a recovery and relay operation and it is strongly recommended that cable trials are performed on the donor cable in a location that provides a sample of all potential scenarios. This is particularly so where the donor cable has previously been buried. Fibre type may also need to be considered and gain flatness parameters deeply analysed. Some cable sections may need to be modified to get the appropriate chromatic dispersion map or the appropriate amplification gain for the new overall system length. Notwithstanding the above, recycling the right cable system can bring great financial and timesaving to a new project.