CAN WE FIX THE CAN ?

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A selected group of staff in New South Wales South & West Region (Consumer and Country Division) have recently conducted an intensive examination and testing process of cables feeding out of eight rural exchanges. The initial aim was to gather information about the real level of transmission related faults, however, the findings create great concern over the degree of DC faults.

With over 350 working services, and as many spare cable pairs tested to date, it can be said that:

* Any customer beyond the 6.5 dB limit, and thus needing either loading or conditioning, is seriously out of transmission specification. Not a single service has been found which is even remotely close to correct.

* Any service operating on loaded pairs, and terminating in a T200 handset, has serious deficiencies in the sidetone level.

* Any service connected via a rural distribution cable method has a 70% chance of having a DC fault (earth, foreign battery or, loss between) sufficient enough to significantly degrade the level of service. An additional 20% have DC faults of a less serious degree. That is, 90% of services exhibit either a foreign battery, earth, or loss between fault.

* Almost 100% of rural Elevated Joints (EJ) exhibit a multitude of DC faults caused by poor work standards.

* Unless a new customer is within a few hundred metres from the exchange, it is impossible to find a totally fault free spare pair to use. That is, the fault rate on spare pairs is even higher than on working services.

* Many lengths of cable are being replaced without justification.

* Faults are not being repaired at all - the service restoration method is to transpose around the problem. This applies to faults in joints as well as cable lengths.

* There is a zero level of field staff understanding of transmission testing techniques and operating principles.

* Modern testing equipment, whilst being adequately supplied, is only being used by a minority of staff. And even then, in limited variety and circumstance.

* Lightning strikes are being encouraged by our own actions. Our focus is on quickly getting to the fault rather than preventing the fault. As a result we are ensuring that we get hit by lightning far more often.

BACKGROUND

Within the ambit of the Transmission Quality Improvement Project (TQIP), it was decided to survey a number of rural services. Initial discussions with others who have tried to do similar, revealed tat to simply try and measure each service was doomed to failure. Past experience showed that lines normally had multiple DC faults which needed to be repaired prior to any transmission testing.

A team of six staff (3 technicians and 3 lines) were selected and then trained. The training consisted of a complete overview of network transmission, dB theory and measurement, hybrid theory, test instruments, fault finding techniques, and cable parameters. Throughout the training period, use was made of "experts" to fully explain each subject. Initially, a classroom environment was used, but then reverting to field training, and practical application.

As a consequence, the staff don't only know about Transmission - they understand it !

A basic work process was developed for the group to follow. This has needed significant modification, and will require more, as the project develops.

The process used is to test all pairs (including spares) from the exchange. Using a Lines Test Set, CZ3000 and Echoflex, DC faults are identified and logged. Then each joint is opened, inspected, corrected, and tested towards the next one. On the rare occurrence that a loading coil is encountered, the circuit is tested with a Simline and HDW T08/3 PET. When lengths which can't be repaired are found (tested with Dynatel 573 and 18B), working services are transposed onto the best pairs, or in extreme cases, a length is run over the ground. When all faults are cleared, long lines are fully tested with the Simline. Sidetone is checked initially by the rather simple "blow/click" method, and if in doubt, an A215 is used to generate 100 dBA CTS into the transmitter, and measured with a Sound level meter at the receiver.

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INITIAL FINDINGS

As a Russian General once said, "the original fail safe master plan only survives until the enemy is first met". And so it was with the CAN transmission group.

The quantity and severity of DC faults were way beyond expectations. Furthermore, most circuits had multiple faults on them - and many were caused by problems in joints. To date, no single EJ has been found which can be said to be perfectly correct and fault free !

Another complication is the faults which have been proven into cable lengths. Given that the aim is to fix the faults, rather than just replace cables, this has meant a lot of digging and repairing. Obviously not all cables can be repaired, and thus must be replaced. When these are identified, a cable replacement report is submitted.

The greatest loss of time can be attributed to the attitude of "don't fix, just transpose around the problem". The problem is so bad that our process has had to be altered so that stage 1 is to now straighten the cable pairs and clear DC faults. It is quite common to find services working over split pairs; more often than not because of a fault in a joint. These splits are frequently on 2 x A legs or B legs - any two wires seem to do: after all, they are only bits of copper! Bad luck about the introduced cross-talk.

Some facts and figures: (with locations identified as 1,2,3 etc rather than by name)

LOCATION	1	2	3	4	5	6	7
SERVICES	41	61	49	35	17	29	92
FAULTY (DC)	5	33	43	35	17	17	73
LONG LINES	16	11	nil	18	17	4	40
TRANS FAULT	16	11	-	18	17	4	40
SPARE PAIRS	29	49	21	24	11	1	58
FAULTY	29	37	18	20	11	8	43
JOINTS (EJ)							
REMADE %	90	90	95	100	60	70	100
REPLACED	3	4	5	7	nil	5	14
DIG & FIX	5	3	6	7	nil	4	19
SIDETONE							
TESTED	nil	nil	nil	15	nil	29	37
WRONG	-	-	-	15	-	14	31

NOTES

1. Location 1 had only 5 services with DC faults over the "Standard SLIQ" levels of 5 volts battery, and 1 Megohm insulation resistance. An additional 28 services had faults of a lower severity.

2. Location 5 was a single route feeding a remote area with all services loaded. This route was used as part of the training program, and thus not fully tested.

3. Location 6: According to plans, the 4 long lines are not outside limits - however, because 0.90 cable has been replaced with 0.64 mm, they now have approx 1 to 2 dB excess loss. These customers have had their sidetone corrected and there is no need to worry about the loss, given that the lines are maintained with absolutely no DC faults.

4. Location 7 had a cable route which fed through extremely rough mountain country. This cable was in very poor condition with many faults in cable lengths. It was decided because of the high cost of replacing the cable, it was viable to dig and repair far more often than would normally be the case. Even then, a section must be replaced due to the ingress of water.

5. Sidetone testing did not take place on the early test areas. We have now progressed to where we test most long lines, plus those within a few hundred metres from the SCAX. Therefore, percentage figures are not valid.

6. The figures for earlier test areas are estimates only. eg: the number of remade joints were not counted because it was not expected that the quantity would be so great.

7. All joints which were not fully remade, still required repair work - there has been no single joint found which did not require correction of faults.

8. Tests on spare pairs are only valid within a short distance from the SCAX. Most spares go to open circuit within one (1) kilometre, and thus, faults detected are within that length. Beyond that, specific figures have not been retained for faulty spares within each individual cable length.

SPECIFIC and GENERIC EXAMPLES

Types of problems found in rural cables and joints include:

No bag over the unsheathed conductors. - this creates insulation breakdown, particularly on the mates. Joints have been found where some wires were completely devoid of insulation.

Excess sheathing removed. - allows the above problem to occur more rapidly, and to a greater degree. The worst example found had 3 metres (that's right, you didn't read it wrong) of stripped cable inside an EJ.

Wrong size jointing posts. - The standard size post can accommodate up to 30 pairs of 0.90 mm cable, provided that there are only the two cables plus lead-ins. Standard posts with up to 50 pairs or with three or more smaller cables are quite common. The effect is to "jam or squeeze" the conductors so that they are in direct contact with the cover. Over time, the results are pairs earthing out on the post, insulation "sticking" to the cover etc.

Twist and sleeve joints on grease cable. - insulation on grease cable is not designed to take the stress of twisting (it breaks the insulation further down the wire). Another similar matter is where the whipping from within the cable has been used to tie off groups rather than using collets. The effect is the same as for twist joints - the insulation in filled cable cannot take the stress and is quickly damaged.

Faulty connectors - this appears to be a contentious problem. Field staff suggest that a certain percentage of connectors are crook and that they, the users, can't do anything about it. Our tests indicate that firstly, this percentage is very, very low, and secondly, if the joint is completed in a slower and more methodical way, any faulty connectors are easily detected. A final visual check of the joint will also highlight any faulty units which have slipped through. Worse case that has been found so far was a complete cable route where every joint had connectors which hadn't been fully crimped. Clearly someone using either a faulty tool or crimping technique.

Particularly alarming is the number of joints found with clear signs of recent activity (eg; one or two pair with new connectors etc) but with numerous other major fault conditions. It is beyond comprehension to understand why someone would open a joint and see that all pairs were suffering severe insulation breakdown, but then only fix a single pair.

Elevated joints which are prone to damage and/or faults create another conundrum. Examples are where cattle continually use our EJs as rubbing posts (and that's no bull)- why do our staff just go along and replace the unit exactly where it was ? There are many ways to permanently solve the matter.

A further example is where joints are located in bad positions such as swamps. This raises the question of the original design, and then the original installation, and then the ongoing maintenance. The best example of this is a joint so deep in a swamp that a pair of fisherman's waders was needed to get to it. The actual joint was permanently underwater except during drought conditions ! Unlike most farmers across the Nation, those in this area pray for drought !.

Transposing pairs has created a nightmare of problems. In order to either connect a new service, or to locate a fault, almost every joint on the route needs to be opened this generates a number of "man made" faults for every one cleared. If the cable is kept straight, then new services can be connected by opening only a single joint. Likewise, a fault can be located to the nearest joint and again, only a single joint disturbed. The findings of the transmission group indicate that the more transpositions which have occurred, then the more fault prone is the cable route.

Tee sections, or multiples, or bridge points (whichever term you prefer) are a further worry. Whilst very few have been found, those that have been, have all existed as a result of confusion within heavily transposed joints. There is no need for 3 wire "O" side connectors. Rockhampton district have not provisioned them since 1980.

Another problem with transpositions is that staff lose the ability (or motivation) to repair faults. It is far easier to simply swap a few pairs. However, if the cable has suffered sheath damage and the fault being chased is not located, the damage spreads like a cancer throughout the length until such time as all pair are affected.

In essence, the practice of transposing pairs is costing us a veritable fortune as it creates more faults; causes a huge man-hour wastage as staff try and sort through the mess; and, generates the need for many kilometres of cable to be replaced needlessly. At present, it is extremely rare to find a cable which remains straight through more than two joints !

TRANSPOSING PAIRS SHOULD BE A CAPITAL OFFENCE !

Marker posts are almost non existent on older routes. As they are lost or damaged, they are not replaced. This has three effects; it causes more lost time as staff try and locate the cable; it allows local farmers to damage the cable with various machinery; and it encourages the transpose mentality. When local staff have been asked why they don't fix faults within lengths, they reply that they don't have time to find the cable. When asked why they haven't replaced marker posts, they answer that they know where the cables are ! Who is kidding who ?

Design deficiencies have also encouraged poor maintenance practices Apart from the 'swamp' example above, we have found EJs (with loading coils) positioned 800 metres from the nearest track, and in very heavy scrub on the side of a mountain. Having walked (climbed ?) up to this particular EJ three times in the one morning to do testing - and carried a number of test instruments, I can guarantee that the inner reserves of motivation are needed to make that last journey. This particular EJs condition clearly indicated that local staff hadn't been able to dig deep enough into their motivation for many years.

SOME FURTHER INTERESTING EXAMPLES OF WHAT CAN BE FOUND:

A cable feeding from the SCAX via a conduit to the local village - when tested it showed as having multiple faults, on seven pairs, "in length". Digging revealed that the conduit was not damaged. When the cable was disconnected and removed it was found that seven metres of sheath was badly ripped - could only have been caused during installation, and never fixed, just transpose around the faults. Why wasn't this cable tested during installation ? Why hadn't the locals detected the cause and repaired the damage ?

A cable was found with no good pairs left - all spares were faulty. Eight working customers on a 20 pair cable, but only 7 reasonable pairs (none were fault free). Solution is simple: just transpose onto a 200 metre length of jumper wire across the ground. Those who advocate transpositions have a lot to answer for !!!

When testing from an EJ, many pairs were faulty within the first metre. The problem was that the joint had been cut back so many times that it was too short to reach. Someone had then re-routed the cable so that it was only an inch or so under the ground. Result was that when anybody was working on the joint and happened to stick a screwdriver or knife into the ground, it went into the cable. The pressure to produce more and more in less and less time, and with less and less staff is producing some very funny results !!!

Multiple gauge changes. For some years we have not used 0.90 mm cable. Faulty sections are replaced with 0.64 or 0.40 mm. This is a cheap initial fix but creates transmission problems that are expensive to fix once the customer complains. The attitude appears to be to replace the shortest possible length and to do it many times. How can the Breakthrough Group halve the fault rate in 18 months when we intentionally install faults?

The worst case found so far is where 7 gauge changes occurred on a group of customers within the 6.5 dB limit (theoretical) - the actual loss was some 4 dB too high. Another example was where there is something which damages (or has damaged) the same cable on a number of occasions - and each time we have simply put in a new section and NOT USED THE SAME START AND FINISH POINTS: that is, the cable was initially 0.90 PE, changed to 0.64 PE (1st replacement), changed to 0.64 PEMB (2nd replacement), changed to 0.64 PEMBHJ (3rd replacement) and the latest change was 0.64 Grease filled. Remnants, ranging in length from 20 metres to 180 metres of each of these cable types were still there, accompanied by 6 EJs and all within 900 metres.

A customer, whose sidetone measured +7 dB STMR (instead of -13 dB), mentioned that Telecom people had changed the handset three times (within the last 12 months) following her complaints of being unable to hear properly. The service was 800 metres from the last coil and he solution was to fit a matching unit (S25/93) across the