Maintenance News

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Contents

Editorial

We were sorry not to have issued an Autumn 78 MN – this was not due to a shortage of material, but was caused by reallocation of work. Apologies to contributors for the delay; and thanks to Derek Knight, the previous editor, for his term 'in office'.

What's in a word?
Maintenance staff at all levels are mindful of their responsibility to provide an adequate service to our customers – and this aspect comes through in many articles in this issue. The word 'customer' is gradually replacing the outmoded 'subscriber'. Would a more conscious effort to use the word 'customer' in all our conversation and communication (including TIs) help to promote this sense of responsibility? I believe so.

Ron Quinney
(01-432 1380)

Satellite earth stations – maintenance philosophy

by **Bob Bowden** ETE/ET16.4.2.

The satellite earth station has evolved over the last fifteen years as a conglomerate of fairly high technology sub-systems, each containing its own special problems and some clearly unique.

The technology is in the van of applied science, consequently little thought was given originally to maintainability. I hope that the following will give some indication of the special maintenance problems which have stemmed from a situation of 'never the same antenna twice'.

Antenna technology 1962-1978

At Goonhilly we have three different antenna designs in use on the Intelsat System, covering the Atlantic Ocean region. Each represents the state of the art at the time of provision and differs from its brothers in several ways. Aerial 1*, completed in 1962 in a blaze of publicity, has a reflector diameter of 85 feet and was originally designed to track 'fast' low-orbit satellites such as Telstar.

* To all intents and purposes 'aerials' and 'antennae' are the same thing, the latter word being particularly well used internationally. However, in ET16 we tend to speak of the 'Antenna' as the basic parabolic structure and the 'aerial' as the antenna complete with its communications equipment.

Although later modified for use with Intelsat 1 – Early Bird – it has remained substantially unchanged since 1965, having a drive system designed for tracking fast moving targets. Microwave energy is fed to and from the feed point at the focus on a tripod in front of the dish, and since this contains electronic components, hydraulic motor and rams, it can be seen that this represents a formidable maintenance problem.

Additionally, to reduce the length of waveguide required, the low-noise receivers on this aerial are located in a cabin, attached to the dish backing structure, which moves with the antenna itself. This leads to access problems and needs an adjustable floor which is parallel with the ground at the 'normal' elevation angle of the aerial.

The surface of the parabolic dish is made from stainless steel in the form of pre-shaped petals, with final accurate adjustment made *in situ* using jacks near the rim. Little maintenance of the reflector is required, but the backing structure, fabricated from galvanised mild steel, requires fairly regular painting. This is to protect it from the relatively corrosive atmosphere at Goonhilly, located as it is on the very exposed Lizard peninsula. There are no serious problems in carrying out this work while in traffic since, although very high effective radiated powers emanate from such an aerial, the region behind the dish remains benign. Access up to the elevation axis area is by stairways but for work above this and forward of the axis, climbing techniques must be used. Such work, which includes the painting mentioned, is applicable to all the antennae, of course.

Aerial 2

This was commissioned in early 1969 and is also a massive structure; the moving part at about 950 tons being only some 150 tons less than Aerial 1. However, a radical design change was the cassegrain 'optics', the prime focus containing a 7ft diameter sub-reflector with the actual s.h.f. feed located in the middle of the parabolic surface and firing at the sub-reflector. Waveguide losses, particularly for the critical 4 GHz receive path, are substantially reduced by such a system, and the feed access is by normal stairways. Unfortunately, the need for tracking information still required that the feed horn rotated and, although the feed and associated bearings are of high quality, there is a need for programmed changes of these at intervals.

The construction of this antenna is fundamentally similar to Aerial 1, stainless steel dish surface on a mild steel backing structure, but with azimuth movement by a wheel and track arrangement. Incremental pointing is carried out using small movements of the sub-reflector by permitting it limited two-axis freedom under the control of hydraulic rams. Sub-reflector offsets are allowed to accrue to several minutes of arc when the main servos are cut-in to drive the

Madley's first Aerial System with a view of the beam waveguide and the relatively lightweight backing and support structure.

structure in a manner to reduce the offsets to zero. This system relies heavily upon the integrity of the hydraulic sub-system located out in front of the dish where it cannot be accessed without a shut down of the whole aerial system.

Aerial 3

In 1972 a third Aerial was completed at Goonhilly and put in traffic on the Atlantic Region Primary Service. This differs from Aerials 1 and 2 structurally, consisting essentially of a concrete tower supporting the 97ft diameter dish structure which sits on a vertical 'king-post' assembly attached to the tower by upper and lower azimuth bearings. Transmitter RF power is routed to the cassegrain feed point by a vertical waveguide through the centre of the azimuth bearings and utilising a rotating joint to avoid the transmitter room having to move as happens in Aerials 1 and 2. The whole azimuth drive system is located under cover and is accessible from inside the structure.

By 1972 a tracking system known as monopulse had been developed which did not require the feed to rotate to detect pointing errors and one clear area of wear has thus been eliminated with this aerial. Again, however, the sub-reflector is moveable with hydraulic rams, although the azimuth and elevation movement rates of the main drives are now sufficiently low to permit tracking on main machinery if required. However, as with Aerial 2 the normal mode of incremental tracking involves sub-reflector movement with accumulated gross offsets corrected by periodic movement of the main structure.

It can be seen that while the use of a primary tracking system utilising beam swing or sub-reflector movement reduces the wear-and-tear on the drive motors associated with the main structure, a penalty is paid since these sub-systems are inevitably located in inaccessible positions making out of service time necessary if maintenance is required. The difficulty of acquiring 'outage time' has become a really serious aspect of satellite system maintenance, since all satellite routes are in a high growth state particularly since the inception of IDD a few years ago. Such problems have led recently to very serious consideration of a 'spare' antenna.

Madley

The last few years have produced substantial rationalisation in antenna design concepts and this has led to the first aerial for the new Madley SES, in use for the Indian Ocean Region service, being radically different from the Goonhilly trio, and engineered with the maintenance of the system in mind.

In recent years certain patents, from Japan in particular, have described the so-called 'Beam-waveguide' technique of transferring microwave energy, by a system of reflecting mirrors, from the dish aperture point to a base-building equipment location at ground level. Because the 'waveguide' in this case is very large in diameter and the energy forms a collimated beam well away from the inside walls the propagation path is effectively free space in the 'guide', and the resultant additional losses between feed (located near the ground) and the dish aperture are negligible. Thus for Madley 1 all the equipment is located at ground level in an air conditioned environment. The relatively 'light' structure of this aerial consists of a 105ft diameter dish with surface fabrication from aluminium 'petals', with a steel backing structure, relying again on galvanising and painting to avoid corrosion. The atmosphere near Hereford is rather less likely to contain salt than in Cornwall, and it is expected that repainting will not be required more frequently than once every three to five years. The exceptional satellite orbital stability has now been proven and although a cassegrain design is used, the sub-reflector is now fixed, with no moving parts in front of the antenna – thus a major potential maintenance headache has been removed. A wheel and track system is used for azimuth movement and the DC drive machinery on two of the bogies is backed up by AC motors with the capability of 'handbarring' the antenna as a last resort to maintain station. With the radio equipment located with its feet firmly on the ground and easily accessible for maintenance we are at last approaching the concept of a 'fully' maintainable satellite ground station.

Equipment reliability

Generally, reliability is achieved by the duplication of equipment which greatly increases the mean-time-between-failures (MTBF) for 'lost traffic' faults.

Routine maintenance is carefully controlled to reduce the possibility of work on 'off-line' items affecting their on-line counterparts *via* the integrated control/supervisory systems. For this, unreliable mains and their susceptibility to lightning-derived transients, have proved a great problem at Goonhilly. At Madley the mains is more secure and the equipment less susceptible fortunately.

Of particular note is that the need for skilled manual filling of low-temperature parametric amplifiers with liquid helium has long gone. Modern paramps use closed-cycle cryogenics and in future will even dispense with this in favour of 'Peltier' (Thermo-electric) cooling which boast MTBFs exceeding 50,000 hours!

Current trends in the detection of tracking/pointing errors will no longer call for 'tricky' SHF phasing but, with 'intelligent step-track', will allow a microprocessor to 'learn' the satellite orbit from simple amplitude information.

Overall (Antenna plus sub-systems) reliability is steadily improving. Although equipment MTBF for some Aerials is below 100 hours the lost service time is very small and comparable with, say, an Inland Radio System. The future holds a prospect of much new applied technology – but now with greater emphasis on maintainability – as we move into the 1980s 'digital' era, involving TDMA (Time Division Multiple Access) Satellites. After an exciting seventeen years of development and innovation it is to be fervently hoped that in the UK, Satellite Communications will come of age with its Earth stations enjoying the kind of reliability at present expected of other PO transmission system terminals. The outlook is good ET16.4.2. (01-432 3631)

Training at the POTTC Stone

By **George Roberts** TP7.2.2

The extent of training provided by the PO was described in MN13. This article offers some further views on training and lists new courses offered at TTC Stone during 1978 and those currently in preparation.

The Telecommunications Training College (TTC) provides engineering vocational training, that is, training for specific jobs. The variety of work in the field is reflected in the number of different training courses. Each course meets a particular job description, the technical education content being limited to that which is necessary to achieve work-based skills. Attendance on a course, however, cannot in itself produce fully skilled staff. An acceptable standard of skill can be achieved only through work-experience and although equipment is provided on most TTC courses, the number of seats on a course and its duration generally limit the amount of work-experience available to each student during formal training. Ideally the student should return to field work on the equipment covered by the course to consolidate and complete his training in the field environment, a situation that cannot easily be simulated on a TTC course. For various reasons, particularly in the case of new systems, this cannot always be achieved in practice.

New courses

The TTC currently offers about 210 different courses with an average duration of 2½ weeks. New courses introduced in 1978 were:

- 119 – TXK3 for maintenance SOs – 2 weeks
- 175 – RT13 for SOs – 1 week
- 178 – RT13 maintenace – 6 weeks
- 179 – RT13 installation – ½ week
- 250 – PABX IBM 3750 for SOs – 2 weeks
- 311 – Dataplex TDM 2A – 1½ weeks
- 312 – Dataplex 3 – 1½ weeks
- 314 – Teleprinter 23A – 2½ weeks
- 344 – Auto Telex Routiners – 1½ weeks
- 348 – Private Auto Telex Branch Exch 2A-1 week
- 459 – HV AC Power Supplies – 1 week
- 468 – Power Plant 233 – 1 week
- 997 – TXE4 Planning for Area Trunking and Grading Officers – 2 weeks

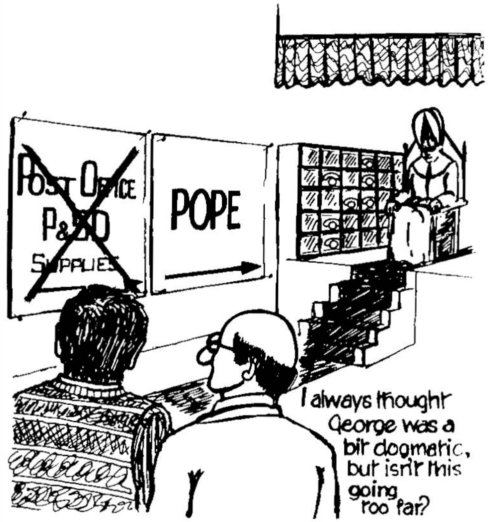
Details of these courses are (or will be) provided in the training brochure which is held in each area training office.

Future plans

Courses currently in preparation are:

- Measurement & Analysis Centres – control & operation
- Measurement & Analysis Centres – processor maintenance
- Measurement & Analysis Centres – peripheral equipment
- Speech-band datel services
- PABX CDSSI
- PABX PDX
- Clerk of Works, Building Engineering Services
- TXE2 Direct Labour Installation for Internal Planning Staff
- Regional Equipment Service Centre (RESC) – repair of digital circuit equipment

In addition, training requirements for Prestel, Facsimile, Accommodation Services, and Optical Fibres, are being considered.
TP7.2.2 (078 583 3631 Extn 303)



Replacement of directors

by **Alan Golding** Sv6.1.3

This article describes a new electronic register translator, the Type 13 R/T (or 'MOST Director' – so called because it makes extensive use of Metal Oxide Semiconductor Transistor Integrated Circuits).

By the end of 1980 we expect only 27 AFN codes to remain served by electro-mechanical director equipment. In the majority of director exchanges the short holding-time equipment will either be replaced with electronic R/Ts or the complete unit replaced by TXK3 or TXE4. The number of AFN codes served by the various systems is then expected to be:

Total number of Director AFN codes	775
AFNs replaced by the Type 13 R/T (MOST type)	*395*
AFNs replaced by the Type 12 R/T (SPC director)	*93*
AFNs replaced by TXK3	*160*
AFNs replaced by TXE4	*100*

Equipment

The type 13 R/T (RT13) is housed in a standard 1.37m-wide Strowger rack using 'short 62-type' equipment mounting practice.

There are two main items of equipment – registers and translators. The number of registers depends on the size of the installation and are connected to the outlets of 'A' digit hunters. Three translators are fitted to every rack for security reasons. Racks can accommodate either 90 or 180 registers maximum, thus a rack of RT13 equipment replaces up to 90 or 180 'A' digit selectors and their associated directors, local registers and routiners – see photograph on page 7.

The equipment uses 24 different MOST integrated circuits (ICs) to perform the majority of storage, timing and logic functions. A fully-equipped 180 register rack contains about 1000 MOST ICs.

For security reasons battery supplies from three different sections are distributed over the rack.

A permanent copy of fault information is produced as a page printout on a teleprinter 15B.

Outline of operation

Fig 1 shows the interconnections between translators and registers. The cyclic stores and logic elements are contained within the translators.

A customer making a call causes the 'A' digit hunter to hunt for, and seize, a free register which then returns dial tone. The register then stores the digits dialled, obtains the translation information from its primary highway, then pulses out the required routing and repeated digits in accordance with a pre-determined sending program of which there are fifteen.

Each of the three cyclic stores contain all the required codes, translation information and sending programs. The cyclic store is basically a large dynamic shift-register. Each translation is stored as an 80-bit word made up of 20 four-bit binary-coded digits. The translations are transmitted to the registers in serial mode on each of the highways after first being checked by the 2-out-of-3 majority logic circuits. Any error within a cyclic store is automatically inhibited and in certain cases automatically corrected. In all cases an alarm is given. All the translations are presented cyclically on the highways, each cycle taking approximately 400ms.

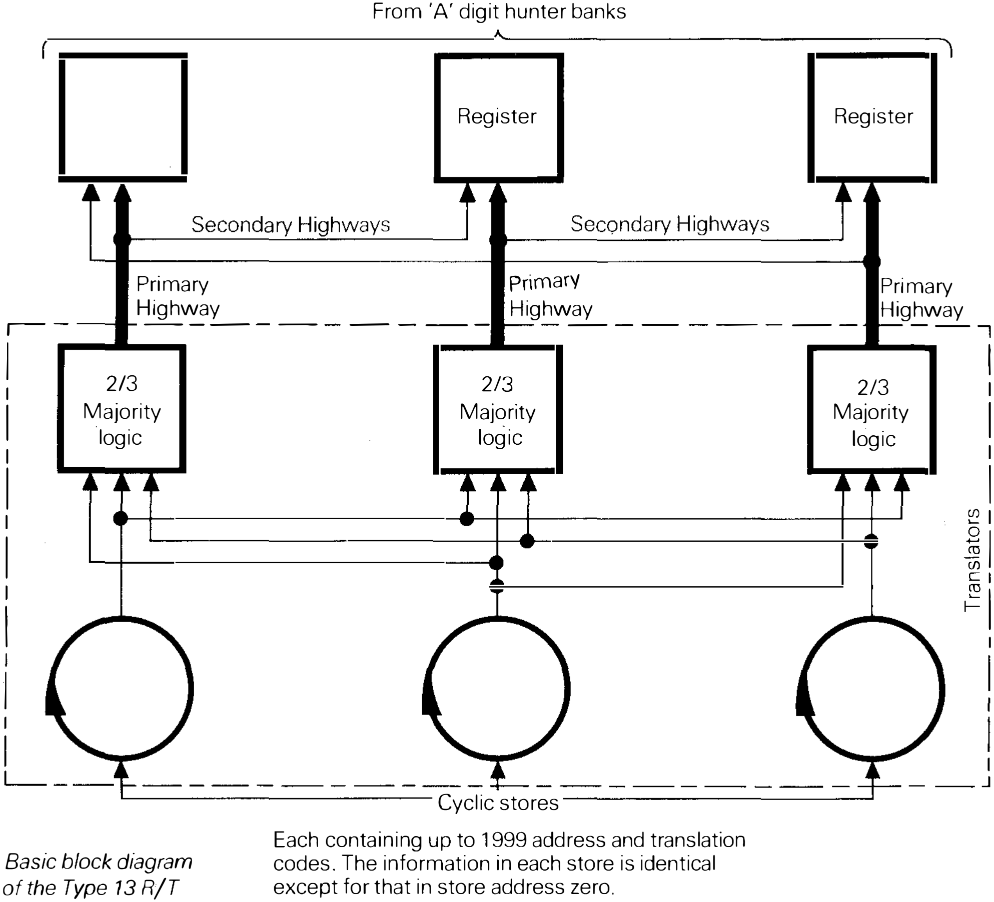
The selected register compares the code dialled by the customer with the address codes contained in the stored information on the highway. When an identical comparison is made, the register stores the 80 bits of information on the highway associated with that code, then enabling the register to process the call.

Although it is possible to store up to 1999 addresses and translations within each cyclic store the PO are only using up to 1599.

Error checking

Each register continually checks its own data highway and if two consecutive translation errors are detected, the register initiates a changeover to its secondary highway. Errors are detected by checking that each 80-bit word had the correct 'sum check' (an 8-bit code obtained by passing the first 72 bits of the translation word through a 'sum check

Fig 1



Basic block diagram of the Type 13 R/T

generator' in the register) – different for each translation.

Security

Each translator provides the clock pulses and translations for up to 60 registers on their primary highways, but a further 60 registers can be supplied on their secondary highways. If one translator fails the remaining two translators each supply up to 90 registers. If two translators fail, the third one supplies up to 120 registers and one-third of the total registers will be locked out of service.

Each translator is provided with a nickel cadmium battery pack to ensure that its data will not be lost in the event of a power failure or when the translator is removed from the rack.

Simple translation changes

A keypad on the Translator Control Unit (TCU) allows translation changes to be made. The 80-bit translation word can be inspected on the visual display unit (VDU) before entering it into the store, but it will not be accepted if the 'sumcheck' is incorrect. Translation changes are therefore quick and simple resulting in a considerable saving in manhours compared with the hard-wired system used on electro-mechanical directors.

TCU

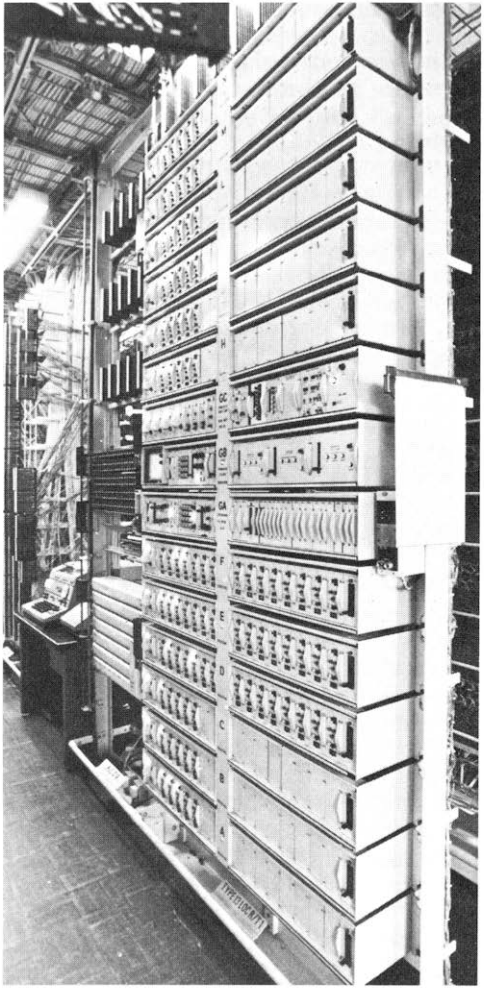
The TCU enables translations to be loaded into each translator either manually by keypad or from a standard cassette tape recorder. The contents of a translator store can also be transferred to a tape cassette enabling a back up tape to be held on site. This can be used to re-load translators in the rare event of total loss of cyclic store information. Loading a translator with the complete store of information from a cassette tape takes about 15 minutes. Also, the contents of one translator store can be transferred to another within 400ms.

VDU
The VDU displays translation, routine and fault information.

Routiner comparator built-in
This enables registers to be routined manually or automatically; normally ten test calls being sent *via* each register in turn in the routiner mode. When the routiner is not switched on, the comparison register automatically searches for a register which has just been seized and works in parallel with this register – any discrepancies found between the two registers during the processing of the call are printed out. The comparison register then searches for another register in the early stages of seizure.

System monitor
This continually monitors the 'status' of each register and translator and, under certain fault conditions, locks a faulty register out of service and initiates a fault printout on the teleprinter. It takes approximately 400 ms to scan all the registers and translators on a fully-equipped 180 register rack.

Traffic meters
These are not hard-wired to the registers as all metering is transmitted *via* the metering highway. A maximum of 80 meters show 'register effective', 'total seizures', 'total ineffective calls' and 'destination call counts.' The destination call count meters (DCCM) can be allocated to particular codes by TCU keypad operation.



General view of RT13 rack

Successful trial
One rack of RT13 equipment was on field trial at Surbiton exchange in 1976/77 and carried all the short holding-time traffic, proving to be very reliable. Analysis of a test call sending programme before and after introduction of the RT13 showed that the number of test call failures was halved, as were those found by TSO and outgoing difficulties reported by customers.

In addition to the improved service experienced by customers, the RT13 reduces maintenance manpower requirements, considerably reduces noise, is more reliable and saves floor area.

Maintenance philosophy
The built-in routiner comparator, system monitor and alarm arrangements indicate faults either as a printout and/or prompt and deferred alarms and/or lamp indications on the registers and miscellaneous equipment. Normally, any faults can be located quickly to particular plug-in units. The relatively low cost of testers and tools has allowed a policy of on-site repair to be adopted.

Routine maintenance is mainly confined to checking that the built-in self-checks are functioning correctly.

Spares
Spare plug-in units are provided on a rack basis to enable faults affecting a shelf of registers to be cleared quickly by replacing faulty units (an

alarm unit is also provided as no alarms are given when this unit is out of service). Spare units are also provided on a per 8-rack basis, but these are not intended to aid faulting and should be used only where a repair to a faulty unit cannot be completed speedily.

Sufficient components for two years are supplied with each rack but, to save cost, a once-and-for-all purchase of the custom-built MOST ICs has been stocked by Supplies Division.

Normally the translation information including sending programs and sum checks will be obtained from the local Trunking and Grading duty but, where cable breakdowns need urgent re-routing of calls, the sum-check will be obtained from a 'Sum-Check Generator' held on site.

Training

For the early installations, two training courses were run at Paul Street RETC jointly by the PO (TD1) and the equipment manufacturers.

Training courses of six weeks duration are now being undertaken by Stone TTC. Courses at Paul Street RETC are expected to start in May 79 depending on the supply and installation of racks. One-week courses for SOs are also being held at Stone.

Programme

Including the early RT13s installed at Paisley and Dalkeith for testing purposes – type approval was granted in December 78 – at the time of writing, there are 11 equipments in the field of the 280 on order from Pye-TMC. With a fairly quick build-up in production rate to an average of 14 racks per month, it is hoped that the installation programme will be completed by mid-1980.

Sv6.1.3 (01-739 3464 X 300)

Call failure detection equipments (CFDE)

by **Alan Wood and Peter Lloyd** Sv6.5.6

CFDE Nos 3 and 4 are provided in non-director and director exchanges which have more than 3000 connections and staffed throughout the normal working day. By sampling live traffic on a random basis the equipment detects faults in the local exchange and junction network, and provides management with day-to-day information on the quality of service. Here we look at some of the probelms experienced with this equipment.

CFDE 3 and 4 have been used for several years at a number of exchanges. Most of the maintenance staff is fully conversant with the equipment which has been generally well received and provides a reasonably satisfactory maintenance aid. As with most new designs, weaknesses in performance and facilities were discovered and a number of Works Specifications issued by THQ to overcome some of them.

Following receipt of numerous A646 reports an awards cases, THQ and Regions discussed all known problems to decide on remedies. As a result, further Works Specs were issued for each equipment. Some of the various aspects are discussed below:

- **Switching to incorrect outlets or not switching at all**

  Investigations showed that because many staff were unfamiliar with motor uniselectors, incorrect adjustments were the most likely cause – this was overcome when the relevant TI was followed. Another factor was that the motor uniselectors were running too fast for their application in many cases. As a result THQ recommend 190 contacts per minute as a satisfactory speed

Digit display meters –

to indicate digits dialled – sometimes displayed incorrect information although the actual call was successful. Whereas this may not have caused any great inconvenience (and may have passed unnoticed) in the *Service Measure* mode, it could – in the *Hold and Trace* mode – have led to lost confidence in the equipment. An earlier cure – where the original pulse monitor was replaced by the current standard PM9A – appeared to lessen the problem, but further reports of incorrect displays led to more exhaustive investigations.

The main problem occurred when the on-going circuit encountered a circuit with negative impedance amplifiers or a PCM route (predominantly those with fully-transistorised line units). Of the various remedies tried the most positive solution involved the provision of additional slave relays in the pulse monitor output circuit. Although the CFDE 3 was not intended to be used other than to monitor local calls or incoming local circuits, it has been increasingly used locally in association with incoming trunk circuits. Unfortunately, the design of the CFDE caused problems in this mode which rendered the use of the standby selector ineffective. Various modifications were used at different exchanges to enable the CFDE3 to be used with local outgoing selectors. However, THQ have now approved a standard modification that can be implemented nationally to permit a wider use of the CFDE on mixed circuits.

The CFDE3 has a built-in safeguard to prevent holding a '999' call should a fault condition be recognised on the forward circuit. Diodes in the CFDE enable it to be released when the second '9' of the emergency call is recognised, but this causes rejection of local calls in adjacent charge groups using 99X.... If the diodes are removed, emergency calls themselves may be held in the 'Hold and Trace' mode – clearly undesirable. THQ have tried various modifications to overcome this problem, including the use of a type 4 uniselector, but this involved difficult wiring. A simpler method, using no moving parts, has been successfully tried and will be adopted.

Thanks

The cooperation of regions and areas in trying out various modifications to improve the efficiency of the CFDE is gratefully acknowledged. Advice of any future changes will be released when they are to be implemented.

Finally, an auxiliary panel – approved following an awards suggestion – is available permitting the CFDE to be remotely controlled. For details, contact your Regional Service Group.
Sv6.5.6.1 (01-432 1342)

How much does a fault report cost now?

by **John Bright** Sv5.2.3

In *MN7* we showed how much a fault report cost in 1975 and stated that "it is now comparable to the capital cost of some of the simpler types of telephone instrument". Since then we have passed through a period of financial change and the cost of attending to a fault report is now *more* than the cost of purchasing a 700-type telephone.

To recap – costs are made up of two components – *direct* costs and *indirect* costs. The *direct* cost of dealing with a fault report is made up of faultsman and Repair Service Control (RSC) labour costs plus the cost of stores used. The *indirect* costs are accounted

RSC	Faultsman	Stores
Costs =	Costs =	Costs =
$\frac{\text{FIA TRL Hours}}{\text{Faults handled}} \times$ Av. manhour rate	$\frac{\text{FIA SU Hours}}{\text{Faultsman visits}} \times$ Av. manhour rate	$\frac{\text{Value of stores booked to FIA SU}}{\text{Faultsman visits}}$
+ Overheads	+ Overheads	+ Overheads
= £2.52	= £7.68	= £0.16

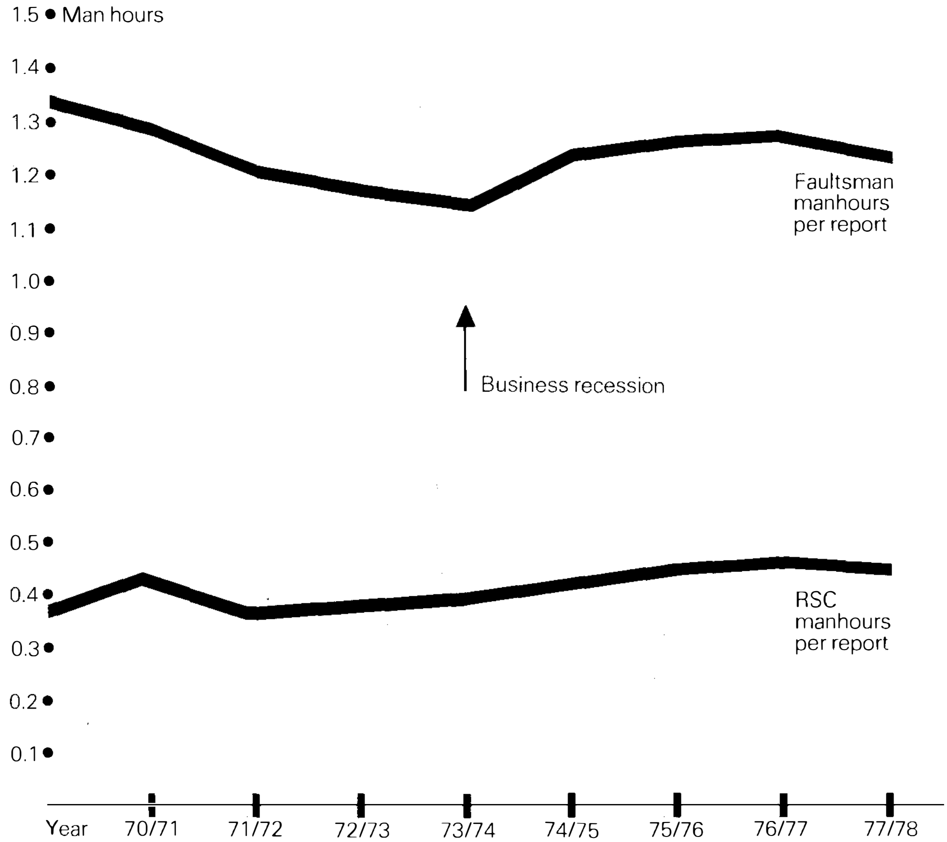
Average cost of a fault report for 1977/78 = £10.36

for by applying the appropriate overhead percentages to the *direct* costs as laid down in *TI L8 E0011*. These percentages are adjusted periodically by Telecomms Finance Department to allow for changes in the various components of the overheads, such as pensions, travelling and subsistence, training, transport, supervision and administration.

The breakdown of costs for 1977/78 shows that the cost of a fault report is more than double that for 1973/74 – which was £4.66. Most of this increase can be accounted for by the change in the average manhour rate, which has doubled in this period; changes in the overheads and the manhours-per-fault also contribute.

The graph shows the average amount of time taken by faultsmen and RSC staff to deal with a fault report. Quite slight variations in the time taken to clear faults can greatly affect the cost of a fault report, because of high labour costs and overheads.

Sv5.2.3 (01-739 3464 Ext 7722)



High grade precautions

by **Ken Hinchliffe** LTR Sv8

If you think about it, the expression High Grade Precautions has several connotations! This article deals only with those precautions applied to 'High Grade' telecomms circuits aimed at minimising the risk of interruptions to service.

What are High Grade circuits?

■ those carrying exceptionally important information concerned either with national defence, electricity, gas and water control, aircraft navigation systems, or fire, police and ambulance services.

■ those which, if interrupted, would inconvenience large numbers of people – programme circuits, press circuits, recorded information systems, and so forth. This category also includes circuits where the PO or customers have a lot of eggs in one basket – PCM systems and carrier systems working on audio cables.

■ those carrying information which is sensitive to transient disturbances – data, facsimile or picture circuits.

Who decides?

The person issuing the circuit provision advice decides whether High Grade Precautions (HGP) should be applied to a circuit and endorses the advice notes, A886s and so on with the abbreviation 'HGP'.

What are HGPs?

Basically, they are a means of drawing attention to the need for extra care:

- by marking in *red* all tag blocks on distribution frames and all test access points
- by endorsing all record cards with 'HG' in *red*.

Where possible, all contacts dependant on pressure (notably fuses in cable terminations) are bypassed with soldered straps. On some exceptionally important circuits screened jumper wires are used to provide mechanical protection, but the screen is left disconnected unless the tag blocks provide for screen continuity (as with music amplifiers).

Six golden rules

Although the intention of HGP is evident, nothing will be achieved unless a simple and sensible discipline is appreciated by all concerned.

- all staff working on distribution frames, in test rooms and those responsible for any other test point must be fully aware of what 'HGP' is all about and the rules that apply.
- circuit provision staff must ensure that jumper schedules are very clearly endorsed 'HGP to be applied', and that all record cards are also endorsed.
- equally important is that jumper schedules for circuit recoveries must be endorsed 'HGP to be removed', otherwise a gradual build-up of red markings on non-High Grade circuits will occur. Knowing this, jumper staff may tend to disregard the HGP rules and the whole procedure will become ineffective.
- Jumper staff must ensure that HGPs are applied and removed as shown in the jumper schedules – the supervising officer is responsible for seeing that this is done by making periodic checks. 'Works Order' staff in test rooms and repeater stations should deal with test points in a similar disciplined fashion.
- controlling testing officers must advise any staff co-operating with the localisation of a fault that an 'HGP circuit' is involved. Afterwards, he should seek specific assurances that any jumpers have been re-soldered, fuse-straps replaced, and so on.
- probably the most important of these golden rules is that *no one* must remove a jumper, test link or cable fuse marked in red, unless he has received a specific indication from the controlling testing officer that fault localisation is required on an 'HGP circuit'. In the case of staff dealing with recoveries, the jumper schedules must be endorsed 'HGP to be removed'.

DC wetting

No article on HGP, however brief, can omit a reminder that *'DC wetting'* (passing a continuous 'background' current through the local ends of a circuit) has two positive

benefits
- helps reduce intermittent 'HR' faults by overcoming the effect of oxidisation at unsoldered joints in the local cable network.
- giving a useful 'click' in the jointer's ear to remind him he is connected to a working pair.

Simple – but effective

The merits of red paint versus red tape for marking HGP circuits (and other relatively trivial details) have been deliberately avoided in this article. But I hope I have reminded you that we do have a simple and effective system for protecting sensitive circuits from human fallibilities and, to some extent, from the shortcomings of our plant.

If I have whetted your appetite for further details, you will find this list of TIs useful. If you are in the LTR make sure you see a copy of *Maintenance Notes no 5* (Issue 5) 1978 'HGP'. It should not be difficult, 20,000 copies have been distributed!

Useful reference TIs

High grade circuits, precautions at subscribers' premises — *C3 R2025*
High grade circuits, precautions in exchanges — *E6 A0110*
High grade circuits, precautions in repeater stations — *E9 B0110*
Repair service controls and trunk maintenance control centres. Circuit information and fault record cards — *E13 A0022*
Labelling and marking in telephone exchanges (MDF) — *A6 D0811*
Jumpering — *A6 D1101*
DC Wetting arrangements, inland speech-band private circuits — *A8 K0601*
Soldering of wires to tags — *E1 A5001*
Plastic insulated wiring, disconnection and re-termination of wires on soldering tags — *E1 A5002*
Protective devices used to safeguard plant connected to external lines — *A2 E0501*
Lightning protection of local plant connected to overhead lines — *A2 E0504*

LTR/Sv8
(01-587 8579)

Finding the PCM-carrying quads

by **Arthur Copeland** Sv5.1.2

Pulse Code Modulation (PCM) is a digital multiplexing technique for combining 24 or 30 speech-band circuits onto one quad of an audio cable. Some special rules apply where cables carry PCM signals

Why is there a need to identify any quad?

An audio junction cable consists of pairs of wires arranged in quads, laid up in concentric layers.

During installation of a cable the sequential appearance of the quads, with reference to their termination numbering, is altered. This alteration results from planned jointing crosses which are introduced at most joints, mainly within layers, to reduce near-end and far-end cross-talk.

Arising from these operations (known as 'cable balancing') it becomes possible only to readily identify specific cable pairs or quads at their terminations. To identify individual pairs or quads at intermediate joints, it is necessary to connect a 'marking signal' to them at a termination and then locate the 'marked' pairs or quads in the joints.

In general, before wire jointing operations are carried out on discrete sections of the cable core, pairs or quads allocated for audio working are identified by using:
- a signal generator (Oscillator no 87) where the identification of the pairs/quads is known
- a signal detector of the capacitive-coupling type (Probe no 5) at the point(s) of work on the cable.

These two items are included in the tester no 132B – see TI *E3 F1901.*

PCM transmission

To reduce the effects of near-end cross talk, not more than 12 quads (24 pairs) in any layer

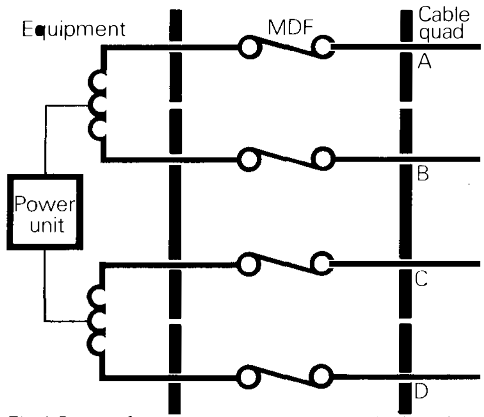


Fig 1 Power feed arrangements at terminal stations (simplified)

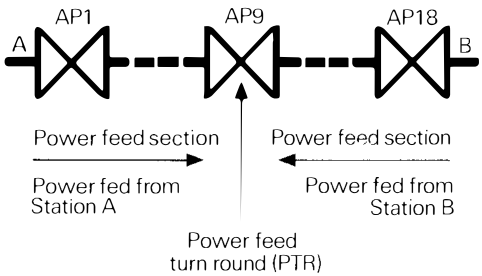


Fig 2 Power feed arrangements: General case

are allocated for PCM working. Normally, all PCM quads in one layer are used for digital transmission in one direction only, thus the 'goes' of the system are allocated to one layer and the 'returns' to another.

The PCM signal is regenerated at regenerator/amplifier points (APs) at specified intervals along the route in order to restore the shape of the digital pulses.

PCM system power feeding arrangements

The power necessary to energise dependent APs is fed from the terminal station over a phantom path derived from each PCM-carrying quad, the two pairs of which are carrying PCM signals in the same direction of transmission – See Fig 1. Where more than nine regenerators are installed between terminal stations, power is fed from both ends. The two sources of power are isolated from each other at a 'power turn round' (PTR) regenerator – illustrated in Fig 2 where AP9 is the PTR.

Identification of PCM-carrying quads

Any direct connection of a 'marking' signal or a signal detector to a PCM-carrying quad will introduce unbalance and render the PCM system unworkable. Thus, to retain it in service during identification operations, the signal is applied to a phantom path. This is derived by means of a tester no 159A, over one pair from the PCM quad to be identified and one pair from an audio-carrying quad. To simplify these operations a spare audio quad in the outer layer of the cable concerned is normally used – one pair to provide a 'speaker' circuit between the termination and the joints, and the other for use in the phantom path.

Note – *The isolation arrangement at the PTR regenerator limits the transmission of the identification signal to within a power-feed section.*

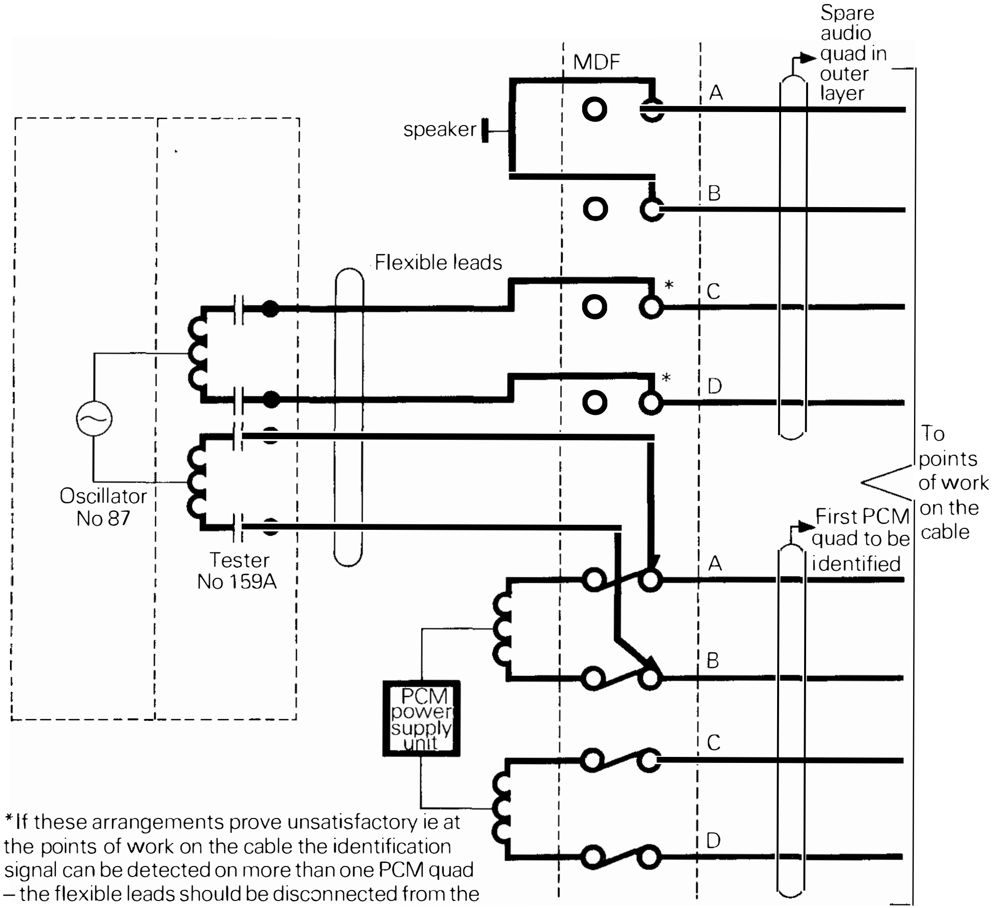
Plan of operations

It is necessary to prepare a plan of work before starting identification operations to avoid interruptions to PCM systems. This includes:

- inspecting the diagram of the CJ cable concerned – to identify the groups of pairs allocated for PCM working
- examining the cable cross section diagram – to determine in which layers of the cable they will be found
- consulting the maintenance officer responsible for the PCM system – to determine the power feed arrangements.

Having collected this information, and having decided from which termination the PCM quads will be identified, an audio quad is selected in the outer layer of the cable. This enables a 'speaker' circuit to be set up over one pair between the termination and the cable opening – the other pair will be used in the identification work.

At the termination this pair and one pair from the first PCM quad to be identified are connected by means of flexible leads to a Tester 159A. The 'marking' signal from the Oscillator 87 is also connected to the tester – see Fig 3.



*If these arrangements prove unsatisfactory ie at the points of work on the cable the identification signal can be detected on more than one PCM quad – the flexible leads should be disconnected from the spare audio pair and reconnected 'bunched' to the station earth.

Fig 3 Connection of identification signal at termination

At the cable opening the marking signal is detected with the Probe no 5 (in conjunction with Amplifier 109 and Headgear Receiver 16T)

- on the pair in the 'speaker' quad
- on the 1st PCM *quad* to be identified

Note *Sometimes it may be found that the signal is detected on more than one PCM quad. If this occurs, the flexible leads should be disconnected from the spare audio pair and re-connected 'bunched' to the station earth.*

It is stressed that this test is to identify the PCM quad only, and no attempt is made to identify the individual wires forming the quad.

To identify the second PCM quad the flexible leads are transferred from the first PCM quad to a pair in the second quad. This procedure is repeated for all PCM quads whose identification is required.

Sv5.1.2
(01-432 1309)

Editor's note – *A future MN article will describe the precautions and practices for 'piecing-out' and change-over wire-jointing operations on an in-service PCM quad, without effecting the system carried.*

Local underground plant in Wales– Improvement plans go on the road

by **Sam Hammersley** WMTB

The serviceability of the local cable network in Wales had deteriorated since 1970. By 1976/77 the faults for every working circuit exceeded the overall figure for the UK by 37 per cent. The fault rate reached such high proportions that WMTB were unable to contain the situation with the available staff, making the overall fault clearance rate (TIP2) 48 per cent worse than the national average.

Clearly, special action was needed. In the spring of 1977 a ten-year improvement plan was formulated in which additional manhours for local cable maintenance and renewal and the installation of new plant with high reliability and low maintenance cost are key features. For the plan to succeed it was necessary to communicate with and gain the co-operation of all the staff involved. A mobile exhibition caravan, normally used for sales promotions, offered the ideal means of achieving this by enabling staff to see the plan 'on their own doorstep'. With a carefully chosen display of photographs, graphs and plant items the exhibition's designers aimed to present a clear message which drew attention both to the overall objective of improving customers' service and how it was to be achieved. A small RHQ team was on hand to discuss details and take note of criticism. The exhibition had three main sections:

Why a plan is needed

Quality of service graphs for the area being visited emphasised that fault reports were rising in relation to the total number of circuits. The exhibition team were to confirm why this had occurred. In the main, early types of polythene cable and the techniques for jointing them had not been good enough. The ensuing fault rate put such pressures on the available maintenance staff that they often resorted to temporary repairs which were themselves a source of trouble. Thus, a poor situation became still worse.

The TIP 2 graph was a clear indication that more UG faults meant longer delays in clearance. Customers reacted to this by repeating calls to RSCs and sending in more complaints by letter.

How the plan will work

Two main objections were presented in this section. They were:

- a reduced fault rate on existing plant and
- new plant installed to such a standard that the fault rate will be very low.

For existing plant a graph showed the extra manhours needed for preventive maintenance, renewing defective plant and improving fault clearance times. Captions pointed out that future preventive maintenance would feature:

- programmed LLIR (local line insulation routining)
- clearance of air leaks on local cables
- renewal of sub-standard plant based on 'black-spot' analysis, LLIR returns and A1024 forms.

For renewal work, emphasis was placed on the need to replace fault prone frontage tee systems on housing sites by radial distributions. Injection moulding will feature in the repair of faulty E-side epoxy putty joints. D-side joints and unfilled cable butts will be grease filled.

Visitors heard how it will be necessary to prove that the plan is succeeding by monitoring the costs of this additional effort. Regional works order numbers covering the work were displayed in the caravan and printed on pocket cards for visitors to take away.

The scale of future installation work was demonstrated by pillar graphs comparing an area's existing number of pairs with those forecast over the next ten years. Captions emphasised the need for both good planning and a high standard of workmanship to avoid a repetition of past problems.

On a practical level a wide range of plant items were on display including a layout of cabling from MDF terminations, injection moulded and epoxy plumbed E-side joints and cross connection points. An experienced instructor from the regional training college was on hand for demonstrations. One which aroused particular interest was on the use of

Sleeves 31A – emphasising the importance of using the correct amount of resin and the appropriate number of cables.

What the plan will achieve
Working circuits in WMTB are expected to more than double in the next ten years but if the improvement plan is effective the UG fault rate will fall considerably. More maintenance staff will be needed until about 1981/82 with a stable requirement thereafter. To demonstrate this, graphs showing the forecasts for UG circuit growth, the expected reduction in the fault rate and the manhours required to achieve this were displayed for each area. Illuminated photographs of renewal work on cabinets, jointing chambers and cables helped created a feeling of 'we mean business'.

Was the show worthwhile?
The success of any plan for service improvements depends on good communication between and within the groups of staff involved. The touring exhibition went to 34 sites and was visited by over 2500 staff of all grades – General Managers and primary faultsmen included. Operators, sales and traffic staff were also welcomed. The exchange of views and experience proved as useful to the RHQ team as it was to the visitors. Reaction to the exhibition was a general eagerness to get on with the job of putting things right provided staff get good direction and are given the right tools.

To help keep the ball rolling a follow-up exhibition will show the plan's progress.

WMTB/S3.1.1 (0222 391 440)

Fault locator for underground lines–'MOLE'

by **John Kentsley** SETR

Measurement and Overground Locating Equipment (MOLE) has completed successful field trials in SETR where it was developed. Improved versions are on the way.

One of the several new features in this 'biscuit tin' sized unit is a miniature 'TV' screen which acts as a visual indicator when locating faults of the high resistance, disconnection, and short-circuit type. In operation, the faultsman jointer (FJ) aligns two pulses on the screen – a marker 'blip' and the 'blip' caused by the fault. Then, by using the meter and a calibrated dial, obtains an accurate measurement of cable distance to the fault. Two ranges are provided – 0-1000 metres or 1000-2000 metres.

Other features of MOLE are:

- location of earth/battery faults by 'bridge' methods
- voltage and resistance measurements as a 'multimeter'
- insulation fault tester

Earth/battery faults
The bridge circuit is far from traditional, as it uses a constant-current source (unlike the Ohmmeter 18A which is constant voltage). This overcomes some problems encountered when trying to locate full or varying battery contact faults, that is, those which either prevent the bridge being balanced, or disappear when test conditions are applied – only to reappear a few weeks later!

Multimeter
MOLE has been specifically designed to give resistance and voltage indications similar to the ranges of the tester *SA 9083* as used by Faultsman Jointers.

Insulation
The built-in insulation tester overcomes the small proportion of faults which do not show up when the relatively low voltage of the *SA 9083* is applied to line. For example, occasional ring-trip or mis-dialling caused by line insulation breaking down to voltage spikes. By operating the appropriate controls, MOLE applies to line a pulsing voltage.of about 300v (current-limited for safety reasons) to break down these particular faults.

MOLE is powered by internal nickel cadmium batteries, rechargeable from the vehicle electrical system, allowing it to be used remotely from the vehicle for up to 1½ hours.

Welcomed
MOLE was developed as a tool for use by faultsman jointers on the local line distribution network – for this reason the range was limited to 2000m. Although still not perfect, MOLE has been welcomed by the 70 FJs who have so far been issued with it. These FJs are finding that the MOLE is overcoming a lot of the frustration involved with fault locations on the polyethylene cable network.
SETR/SM3.4
(0273 201793)

A welcome reduction in BUMPH!

by **Ron Quinney** Sv 5.4.2
Maintenance Division TI Adviser

If bumph can be defined as unwanted, non-essential documentation, then any reduction must be welcome.

In March 1978 THQ Circular E6/78 announced that action was about to be taken on reducing the number of unnecessary TIs carried by mobile maintenance staff. This 'comb-out' has been completed.

- Why was it done?
- How was it done?
- What problems has it caused?
- What of the future?

Why?
The comb-out was started in response to criticisms from maintenance staff with mobile duties that too many unwanted and unnecessary TIs were being distributed to their files (type 1 files). This over-distribution resulted from a combination of errors when the TI system was established and an accumulation over the years of instructions that were felt nice to have ('just in case') rather than following the philosophy of TIs – see *K3 B0011*. This states that *"when management is doing its job and staff have been properly trained, instructions are required to provide only that additional information necessary for staff to do their job effectively"*.

How?
In 1976/77 sample opinions were obtained from staff with type 1 files in areas, including those with customer apparatus, datel and telegraph maintenance duties. Also, every TI was examined for its relevance to a type 1 file by the THQ Sv5,6 or 7 operational group responsible for day-to-day maintenance. As a result, instructions were prepared for the removal of non-essential TIs from such files. The computer used by Edinburgh TI Distribution Centre was programmed to delete these TIs from the records of over 14,500 type 1 files resulting in a saving of at least 200,000 instructions!

Problems
As expected, some problems have been brought to light but, with careful consideration of the underlying causes, most have been resolved. For example, all mobile staff should have reasonable access to types 2 or 3 files (those containing descriptive and parts TIs and so on) at their workshops, controls or HQ, but some supervising officers have found the appropriate *basic duty* codes missing from these files. In a few cases, where station files were found to be type 1, it was decided to upgrade them to a type 2. Also, some rural areas have found problems due to the geographical locations of files, but no doubt local management will have these reviewed and make necessary changes.

The future

Within THQ/SvD, authors and authorising officers of maintenance division TIs have been instructed to bear in mind the following before putting pen to paper:

- the staff to which a TI is addressed
- the use of plain, direct language
- use of flow-charting methods when warranted
- avoid over-distribution, to type 1 files in particular
- regular review of TIs and updating as soon as changes occur

Other ideas under active consideration are:

- printing TIs suitable for filing in 'N' diagram wallets for use by mobile staff
- marking TIs for type 1 files so that supervisors know which instructions should be held by their mobile staff
- producing Index TIs for *basic duty* type 1 files showing TI and current issue numbers which should be found in every basic duty file.

The steps that have already been taken will, I am sure, make for a happier staff relieved not only by a welcome reduction in *bumph* but also by knowing that improvements to TIs are constantly under review.

Sv5.4.2 (01-432 1380)

Terminating on cabinets

by **Dennis Ansell** Sv5.1.1

Cabinets Cross Connection (CCC no 1, 2, and 3) are provided as above-ground flexibility units between exchange (E) and distribution (D) cable pairs in the local line network and have now been in use for over 30 years.

Until 1972 the standard method of terminating cables in a cabinet was by a variety of screw-type assemblies. The last of these was the assembly PC 100 which accommodated 100E- and 100D-side pairs and was pre-wired with separate tail cables of either 30ft or 60ft lengths. The basic design of all types was similar – a complete assembly comprising a number of plastic moulded tag blocks for terminating the cables, and nuts or pressure screws for interconnecting the E- and D-side pairs by means of bridging pins or jumper wire. However, over the years all assemblies have been shown to be inherently prone to:

- low insulation and corrosion in damp atmosphere
- disconnections or unstable connections due to loose pressure screws caused by traffic vibration
- broken pressure screws through overtightening.

Because of the potentially high fault rate and, in particular, the difficulty of removing low insulation and corrosion deposits from within the blocks, other means of terminating the cables were examined.

Fortunately, when aluminium conductor cables were introduced into the D-side network in 1967-8, a new method of jointing the pairs evolved, using a crimp-type connection known as the Connector Wire Insulator no 1A (CWI no 1A). Using this principle, several methods of terminating were trialled including the C800 and MTR shelf-type terminations, eventually culminating in the Strip Cross Connection no 1 (SCC no 1) – see Fig 1. This was generally introduced in 1972 as the standard method of terminating.

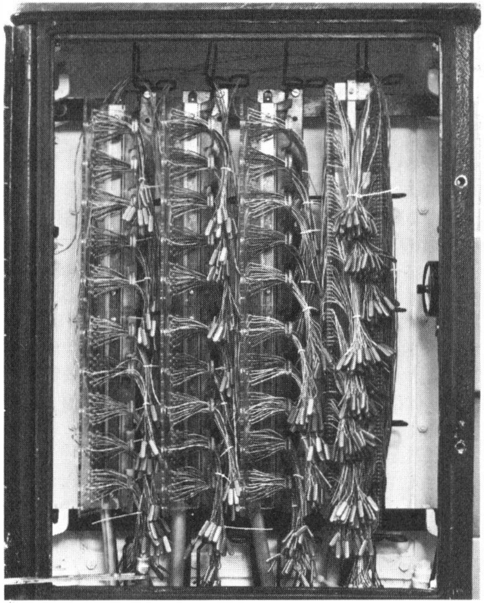


Figure 1
Cabinet containing three SCC No 1 with SCC No 2 on the right. Note the use of holes, slots and straps (see text).

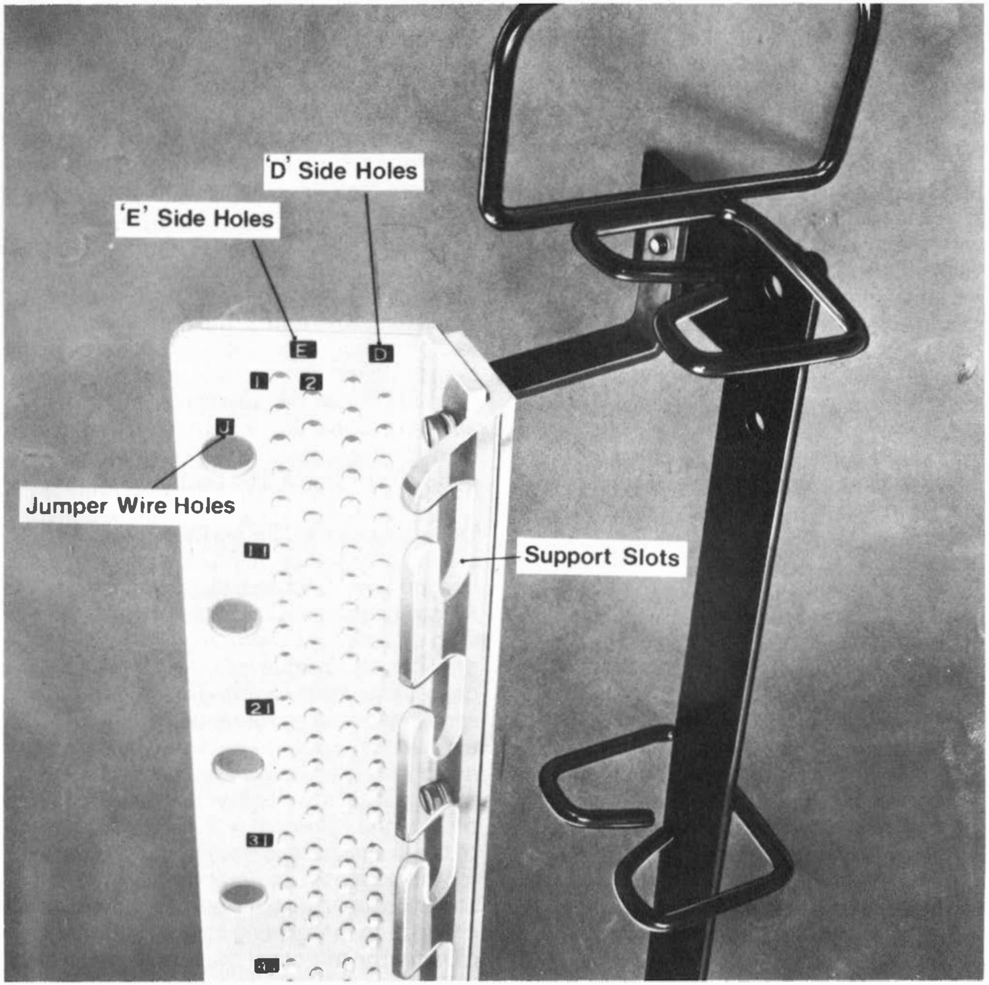


Fig 2 Close-up of SCC No 1

The SCC no 1 accommodates 100E- and 100D-side pairs. It consists of a plastic moulding containing a pattern of numbered holes through which the E- and D-side cable pairs and jumper wires are passed for terminating – see Fig 2. Pairs are arranged in ten groups of 20 (10E + 10D) and, within an individual group, pairs can be directly connected. Interconnections between groups on the same strip or an adjacent strip are made by jumper wire. All connections are made with CWI no 1As. The groups of pairs, including jumpers, are neatly formed and loosely tied with Straps Cable Fixing no 1 and placed in their appropriate support slots.

CCCs no 1, 2 and 3 accommodate 4, 6 or 8 SCCs no 1 respectively, giving a terminating capacity of 400, 600 or 800 E- and D-side pairs. While this is satisfactory for most planning and development requirements, difficulties can arise in high density telephone areas when it may be necessary to sub-divide a cabinet area and provide an additional cabinet and cabling to meet the circuit demands. To overcome this problem the SCC no 2 (capacity 200E- and 200D-side pairs) was introduced. Use of these strips is restricted under RD (Sv Divn) authority and then only after cost studies have been done – *TI A2 C1115* refers. The increased terminating capacity calls for great care by everyone working in the cabinet to ensure that service standards are maintained.

Following the introduction of the SCC no 1, it was found that the aluminium conductors used in the local D-side cable network were susceptible to disconnections, so copper tails were used for the termination. But in 1973 aluminium alloy cables (petroleum jelly filled) were introduced into the D-side and it was found that these could be terminated directly onto the SCC no 1. Recent trials of similar cable (air spaced) in the E-side have also proved satisfactory for direct termination.

Benefits
Direct termination of cables onto strip-type connections offers these important benefits

- reduced low insulation and disconnection faults
- reduces congestion, and potential faults, by avoiding large E-side multiple joints and a conglomeration of small D-side joints
- reduces number of jumpers because E-side pairs can be distributed over the strips so as to be opposite their respective D-side pairs – TI *A2 C1116* refers.

Don't create birds nests
With increased SCC population (by additions on new work and maintenance replacement of faulty assemblies) an overall improvement in fault rate should materialise. But to maintain this improvement or even better it in the long term, staff must observe correct practices when working on strip-type connections. SCC's are often left very untidy, somewhat representative of, and frequently referred to as, 'birds nests' – because of the manner in which the pairs and jumpers between adjacent groups have become entangled together. Always:

- replace the Straps Cable Fixing no 1 around the groups of pairs
- avoid direct connections of pairs between adjacent groups
- avoid running jumpers outside rings or directly across the face of strips

Be tidy
Bad practices make it difficult to locate individual pairs, and excessive handling of the wires could eventually damage conductor insulation and cause short-circuit and insulation problems. Everyone should exercise more care and attention when working at cabinets by leaving the SCCs, and assemblies if present, tidy even if this means spending a bit more time at the site. This will assist the next visitor to the cabinet to carry out his work more efficiently, minimise the risk of fault and, hopefully, put an end to bad practices.

New label
A new self-adhesive label (label no 521A) has been produced to remind staff of the correct practices to be observed at cabinets. It is available as a *vocabulary* item.

Records
Finally, a word on cable pair appropriation records. As these play an important part in the upkeep of local line plant, whenever a pair is 'changed out' to restore or provide service, *Always* inform the RSC or EPMC, as appropriate. A form A1057 is then issued to the Installation Control (Routing and Records duty) for updating the master records – TI E3 A0617 refers.
Sv5.1.1
(01-432 1373)

What is TCSE?

by **Alan Short,** TMS5.4.2

Trunk Call Sampling Equipment (TCSE), an electro-mechanical system, has been in use for more than ten years. It is connected to register access relay sets to record details of STD calls.

About 150 equipments are fitted at 132 selected GSCs, covering about 75 per cent of originating STD traffic. The equipment samples about four calls every hour recording details of time, date, source or origin (ordinary or coinbox), charge, duration, meter pulses and destination. The information is punched on 5-channel paper tape by a reperforator 5C or 5E and processed by central computer.

What makes TCSE so important?
It's the only source of information on STE call holding time durations, distributions and average number of meter pulses. Combined with effective call meter readings TCSE provides an accurate measure of the UK STD call revenue each month. This, with other similar information for rentals and so on, enables the Business to identify and resolve its short-term cash flow problems. Each month, TCSE statistics with other information, provide the PO Board with detailed forecasts of the likely financial position of the Business for the current year. Additionally, TCSE statistics are used to review and formulate changes to the existing tariff structure and to monitor the effects of the changes.

Errors could lead to mistiming tariff changes and pitching our charges at the wrong level.

This in turn, taken with the general economic situation, could lead to a fall in the calls made and a decline in the profitability of the Business.

Thus TCSE helps the Business and the Board to avoid 'managing in the dark'.

Need for further development

The accuracy of the results depends on the quality of the data submitted. While general serviceability of the TCSE has been good enough in the past some deterioration is being experienced as the equipment sets gets older – particularly the reperforators. Additionally, with the introduction of more sophisticated computing equipment, the handling and reading of paper tapes becomes more difficult. On top of these problems bias is being introduced into the statistics because, following regrading in GSCs, not all 'A' leads are reconnected to the equipment, and those that are do not conform to the correct sampling configuration.

With the current economic uncertainties, it is now more important than ever that regions have an accurate picture of their own finances and that the national picture is built from the bottom up and not from the top down. However, with the present levels of serviceability, though the UK statistics are reasonably accurate, those for individual regions are not. Even if current levels of serviceability are maintained, and this is by no means certain, an additional 40 TCSEs will need to be installed at an initial cost of £400,000 to give fairly accurate regional statistics. A reasonable improvement in serviceability could reduce this by half

And what is THQ doing about it?

- *Works Spec NPD TE4019 to change the 'l-in-N Sampling' system to the 'Consecutive Sampling' basis increases sample size and reduces bias. More equipment modifications which assist maintenance staff are in the pipeline*
- *Development work is in hand to replace TCSE with other equipment but this may take up to ten years to become fully available.*
- *Trials are taking place on a new 'less sensitive' paper tape reader at the computer centre which, when taken with other computing changes, should enable faster and more accurate reading of tapes.*
- *Factories Division is setting up a system for refurbishing reperforators on a systematic basis. Additionally about 50 reperforators 5E should be released when traffic measuring at TXE4s is automated.*
- *Changes have been made to provide error reports on a weekly, instead of a monthly, basis.*

What can you do?

Well, if you've got TCSE in your exchange:

- Ensure a tape is sent in each week.
- Ensure that the tape is cut in the right place. Large blocks of data are lost because the first 'header' on the tape is at midnight Monday/Tuesday rather than at midnight Saturday/Sunday.
- Make sure the reperforator is properly adjusted
- Check the headers to make sure they're OK.
- Ensure that the routine tests on both the reperforator and the equipment itself are carried out in accordance with the TIs.
- Check the weekly exceptions reports and make full use of the direct print facility.
- Check the 'A' lead connections.

THQ/TMS 5.2.4 are always pleased to give help. Get to know your Regional TCSE contact who can pass your problems on to us.

TCSE TIs are listed below:

TI K2 E0012	*Trunk Call Sampling Equipment (TCSE) Appendix C deals with the interpretation of Exceptions reports.*
TI E6 G4101	*TCSE – Maintenance. This is a general instruction – Para 4 deals with Out of Service arrangements*
TI E6 R5760	*TCSE – Functional Test Maintenance Routine Instruction*
TI A6 C3021	*Design of Main Network Switching Centres TCSE Principles – Para 3 deals with selection of circuits.*
TI A6 C3022-34	*Design of Main Network Switching Centres TCSE – These are very general instructions principally listing all TCSEs and their numbers.*

TMS 5.2.4 (01-432 5404)

LTR's computer-aided fault reference centre

by **John Reilly** LTR

Since 1976 the processing of fault information from AMCs in the London Director Area has been assisted by a computer – resulting in speedier identification of fault patterns in the network compared to the earlier manual methods.

Fault reference centres were first set up in the late 1960s to cover most of London's non-director GSCs, also a centralised STD reference centre was established for the London director area. However, as a single reference centre for local call failures in the director network (400 exchange units, 7 tandem exchanges and 7 sector switching centres) would have been large and complex, it was decided to set up two experimental centres. One covered the four inner-London director areas and the other an outer director area.

Computerised

These original centres quickly proved their value to local network maintenance in the LTR. But it soon became apparent that manual reception and plotting of high numbers of fault reports were difficult and that computer techniques would be necessary. With the active support of THQ/SvD and DPS a Ferranti 700E computer was installed. This became operational in July 1976 processing information received from AMCs in the four central areas. Since then it has been progressively extended to cover the whole LTR director network served by 32 AMCs.

Information about customer dialling difficulties received from these AMCs is keyed directly into the computer by the reception staff without the need to prepare a hard copy. This considerably increases the speed of operation. Each message input consists of the calling exchange AFN code, the exchange code and number being called, and the reported failure. The computer associates with the failure report routing information for that call obtained from translation information held within its files for the originating unit concerned. The reports are stored in the computer's files and when a pre-set parameter for any file is reached, a teletype printout details all failures on that particular file.

The task

The average number of reports received from the 32 AMCs each week is about 20,000 which results in about 1400 fault patterns, which are passed to maintenance staff in the local units. This in itself is impressive, but what is more important is that by using a computer for this purpose there is a greater chance of faults being removed from the system before they further degrade the quality of customer service.

Developments

Improvements to the computer are in hand which will allow high-speed printout at the collecting points in the seven outer areas using Transtel printers. This information will then be passed quickly to the respective units for action. A recent development allows the computer to progress outgoing STD fault reports by correlating them according to their number group code and the outgoing trunk unit in London. If different number group codes route over the same trunks from London, they are linked together within the computer file for joint correlation. The correlated failures, output in the London Reference Centre on a teletype, are then dealt with by engineering staff in conjunction with maintenance staff in the trunk units.

Vital factors

Reference centres depend for their success on two vital factors.

- Quantity of fault reports.
- Speed of reporting, processing and identification of fault patterns and taking appropriate action.

The use of a computer, coupled with enthusiastic support by AMC and maintenance staffs, has enabled both of these factors to be achieved. It has ensured the success of Reference Centre working in the LTR in making it an important part of the jigsaw of maintenance activities.
LTR/Sv2.2 (01-587 7387)

Signalling display equipment in the External Telecommunications Executive

by **Ken Foxley** ET10.1.1.4

The high speed signalling systems introduced for international circuits in the 1950s needed a digital display of signalling events as they took place. Also needed was means of storing this information for later diagnosis to allow maintenance men to observe signalling activity when they were tracing call failures.

Various firms have designed equipment for this purpose. The type described here – now being brought into service in the ETE – is the Northeast Electronics (NEC) 2760.

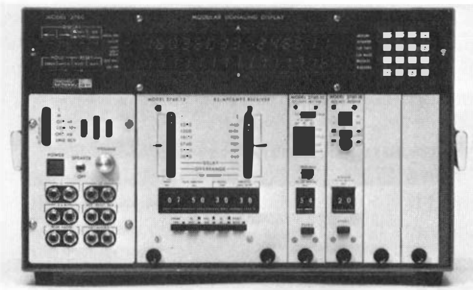
The NEC 2760 evolved from earlier NEC signalling display equipment. This was developed to deal with telephone calls involving circuits using the R1 signalling system (MF1 inter-register signals with 1VF line signals) throughout the North American Bell telephone network. One of these earlier equipments, the NEC 2762, can check, decode and then display up to a maximum of 16 digits. It can also indicate the current supervision state of a circuit as either on- or off-hook. It is the experience gained from this version, modified for 2VF working on intercontinental circuits, which has led to the development of the NEC 2760.

Micropressor controlled and modular in design, the 2760 caters for a variety of existing in-band signalling systems and, with a suitable receiver module, could cater for new ones. So far, signalling modules have been fully or partly developed for the following systems.

UK national: *AC9, AC11, LD, MF2, MF3*
International: R1, R2, MF1 (Part of CCITT no 5) AC10 (also part of CCITT no 5), MF4, AC4 (CCITT no 4), E&M.

Besides housing a receiver module and a microprocessor the main frame houses:

- Power supplies;
- A memory which holds the program and stores data extended from the receiver module;
- A dual 16-digit display which indicates either the incoming supervisory signals or digits as they occur. (The user can switch from one to the other without loss of information on recall).
- Control keys;
- A keypad to enter program changes;
- Sequence match number patterns;
- LEDs which indicate some of the supervisory conditions and the state of the 2760 itself.



Using the NEC 2760

Supervisory signals are presented on the upper or A display, while the time in hours, minutes and seconds is displayed on the lower or B display. This time check will be used with a printout facility to be developed later. The recall facility enables information to be scrolled out into the display, 16 digits at a time, from a 240-digit store for detailed inspection using a cursor. The cursor can be moved along the display to allow any data stored in the memory to be brought down to the appropriate receiver module. This is particularly useful when faulty digits have been received; for example, an MF2 digit with other than two frequencies. The main display shows a minus sign for each faulty digit. This indicates the reception of one or more signal frequencies which cannot be decoded. The actual frequencies received are displayed on LED's on the receiver module. In this way the information stored for each incoming digit can be recalled in detail, one vertical pair of displayed digits at a time.

Signalling modules can be used independently, or, where appropriate, in combination. For example, the MF1 and the AC10 systems provide respectively the inter-register signalling and the line supervisory conditions for the CCITT no 5 system currently used on intercontinental circuits; so both can, if required, be monitored at the same time.

The equipment's facilities stem from the need to monitor a circuit for both technical and traffic analysis purposes.

In the technical case, signals are tested to determine their meaning and are displayed provided that the programmed signalling limits are met. If these limits are not met details indicating the discrepancy are displayed as far as possible. For DC signalling systems, potentials, polarity and timings are checked. For AC signalling systems, frequencies, signalling levels, timings and signalling format (MF digit errors) are checked either against standard parameters or against programmed variations under user control. When signalling conditions fall within the programmed limits an indication is given on the main frame to show that a supervisory condition (seizure, answer, clear and so on) has been detected or that an acceptable train of digits has been received. If the supervisory signals fall outside the required timing limits, but remain within a 'grey area' which can reasonably be interpreted as a supervisory condition, then the condition will be displayed as marginal.

When the need arises to examine digits, the ability to vary the test limits enables trains of digits from a faulty register or sender to be examined against various standards. This enables timing, format and other faults to be diagnosed. As these tests are applied on a per-digit basis and the results can be recalled in detail, intermittent faults such as the sending of spurious tones, 2-out-of-6 errors or irregular timing of digits, can be diagnosed.

In the few cases where AC signals are distorted beyond the limits of the NEC 2760, a rectified output is available. This permits a chart recorder with a limited frequency response (the ELCOMATIC for example) to display the envelope of the signals, showing the transmit and receive paths separately if monitoring a 4-wire circuit.

By this means severe timing or level errors, split signals and so on will be revealed.

This facility, however, should not be required very often.

A point worth noting is that, as a result of its high impedance input, the NEC 2760 is capable of monitoring 2- or 4-wire circuits together with E&M wires without loading the circuit. It is also able to display information correctly when the circuit being monitored is bothway working (AC9 or AC10 for example). This is done by detecting the arrival of a seizure signal on the transmit or receive wires and then setting the logic to react to signals in the appropriate manner until the circuit becomes idle again.

Detecting unauthorised traffic

The NEC 2760 can be set to alert exchange staff if, say, a call to a particular destination appears on a circuit. To achieve this it is programmed to look for specified digit combinations (sequence matches) and will give a closed relay contact output if any of these are detected. This facility can be tied to an exchange alarm system or can drive a suitable counter. Up to ten number patterns, each between one to 16 digits, can be entered into the memory by means of the keypad for this purpose.

Congestion

Another problem which can be identified by the 2760 is congestion over MF2 transit routes to particular destinations. This is done by monitoring the backward MF2 digits and noting, during the course of setting up a call, when failure occurs. Later, it may be possible to select and print-out such calls as well as those in other categories. This would be done using the sequence match facility, a printer control module and a suitable teleprinter.

The NEC 2760 has a wider basis for use than the features mentioned here. But experience with the various prototypes, together with the production main frames and the R2/MF2 receiver modules, has proved that it is a powerful tool capable of dealing with signalling and traffic problems on international services.

ETE/ET10 1 1.4
(01-353 8526)

Non-director international equipment maintenance–The coinbox enigma

by **Brian Sapsford** Sv 7.2.3

A fault on the equipment at non-director Group Switching Centres (ND GSCs) causes occasional failure of the forced-release sequence on barred intercontinental calls. The result is a large number of calls going worldwide – mainly to Hong Kong, USA, Israel and several Arab countries – for which the PO is charged in full on the international account but for which we may collect as little as 2p per call. When offenders suspect one of these faults they flood the exchange with barred coinbox (CCB) calls in an effort to pick-up the faulty equipment. Each attempt results in a seizure of the International Switching Centre (ISC) equipment thus adding considerable congestion to already heavily-loaded networks. At one exchange over 20 000 attempts were recorded in a 24-hour period. Modifications which will apply a more reliable forced-release condition to the CCB Register Access Relay Sets (RARS) on barred calls, before association of the International Call Timer (ICT), are now undergoing field trials at Brighton and Uxbridge. Nevertheless there is still an urgent need to improve our test facilities. This article outlines new procedures to be adopted.

Currently 245 ND GSCs have the facility to route calls to the ISCs and thereby gain access to some 83 countries. The equipments providing this facility are complex and widely different. To enable calls to be routed and metered correctly the various equipments must all associate and interwork correctly.

Some problems overcome

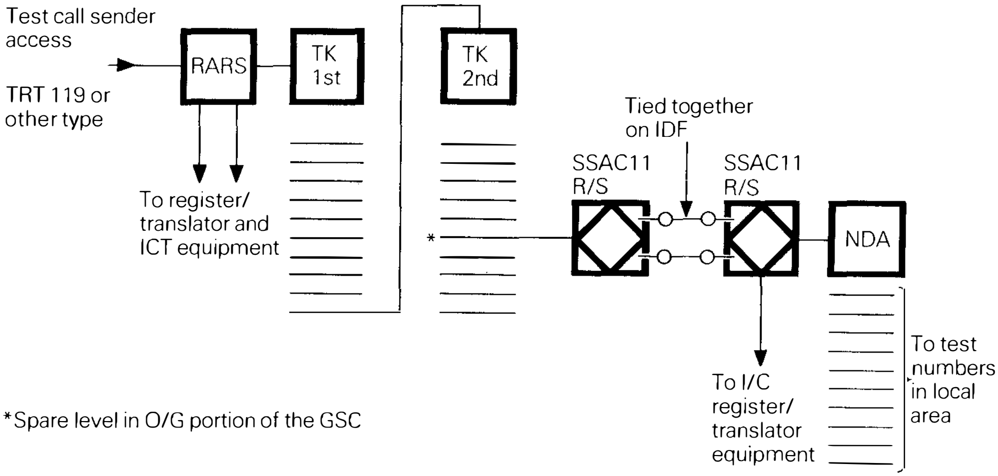
The controlling register, translator and SSMF no. 2 sender/receiver are routine tested with a Multi-Frequency Test Unit (MFTU). Approval has now been given for the International Register-Translator (R/T) to be included, but this requires extensive modification to the MFTU. Arrangements have been made with Factories Division for the MFTU rack to be exchanged for a modified one from a pool of MFTUs. Suitable test equipment is being developed to ensure that each site receives a fully working item. As provision of the fully modified MFTUs is likely to be a lengthy business, arrangements have been made for a small modification to be undertaken locally which will enable a restricted series of tests to be carried out on the International R/T by the existing MFTUs. Details of the modification is contained in Work Specs NPDTE 7089 (for Type 2/3 R/T installations) and 7093 (for Type 5 R/T installations) available from Regional Planning Groups.

Even allowing for the provision of a full-facility MFTU there remains other equipment that has to interwork with those mentioned above which cannot be tested for full interworking capabilities. This does not mean that testers like the TRT 227 (ICT Tester) do not detect faults – they do and are quite effective for that *part* of the system for which they were designed to test. However, one of the biggest problems is to ensure that *all equipments required to set up and receive international calls can associate and interact with each other in the correct manner.*

A meeting of area, regional and THQ representatives decided that an in-house 'back-to-back' testing facility would go a long way in providing overall testing facilities. A successful scheme was undertaken at several centres throughout the country involving the provision of a 2-circuit route, initially using spare SSAC 11 Relay Sets, within the GSC. It enables test calls to be passed from RARS's in the O/G portion of the GSC, via the 'back-to-back' route to the I/C portion of the GSC and thence to test numbers in the local area. A simplified diagram of the scheme, as applied to a TXS GSC, is shown in fig 1.

Arrangements have been made to provide this testing route as a national standard for all ND GSCs, including TXK, and details are contained in THQ Circular *S1 A7910.*

Our colleagues in ETE indicated that country codes in the OXX range would be suitable for testing purposes. The two digits XX being chosen to suit local routing arrangements as one must bear in mind that the I/C R/T equipment will see the first digit of a country code as a 'C' digit of a nationally dialled number. If it is not possible to use an OXX type



*Spare level in O/G portion of the GSC

code the codes 83X, 683 and 284 may be used. A word of warning at this point – *test calls using these codes (including OXX type) should not be passed to any* ISC.

Programmes of test calls can now be sent from RARSs to test number relay sets in the local network. An assessment thereby can be made of the service given to customers by the equipment in that exchange without the need to contact other exchanges when fault tracing and clearing activities are undertaken. It is considered prudent that, having established the test call, a check be made of the correct metering conditions (see above). Now, to return to the opening statement about call barring facilities not working. How can we check these?

Checking call barring facilities

One answer is to use the back-to-back route and pass test calls from CCB RARSs which use an OXX code, strapped up to give an intercontinental fee digit, that is, charge band 5A or B, and ensure that every call in the programme is barred and NU tone returned. This call programme would have to be run apart from the other programmes. But on most call senders it is not too difficult, and a short programme of, say, 50 calls at a time, run at a different time each day, would keep a check on the ability of the equipment to bar the calls to such routings. The code used should, of course, be the same as used to check the normal operation of the equipment but made from CCB RARSs providing that the highest charge band was translated for that code.

Summary

Extension of the test facilities of the MFTU to test the International Register, albeit in a restricted manner, is recommended pending the larger modification. Provision of the 'back-to-back' route, in all ND GSCs equipped, or being equipped, for international working, should go ahead in accordance with THQ Circular *S1 A7910*.

In the fullness of time certain TIs and other documents will be amended to provide this as a standard facility in all ND GSCs with ISD.

Sv7.2.3
01-432 1364

TXK1 Local exchanges–Improved computer fault analysis

by **Alan Kelly** Sv 6.4.4

Computer analysis of the equipment monitor fault printouts has been available for TXK1 local exchanges since 1971. The computer finds fault patterns which would have been difficult to identify visually, especially in the larger exchanges. This was the first attempt by the PO to analyse by computer the fault reports from a common control exchange. It was in the light of the experience gained that a new program was written and has now been put into use, resulting in better indication of obscure faults and better guidance on manual routines required.

The computer input

The input to the computer is a paper tape, containing a copy of all the information that is presented to the equipment monitor teleprinter. This includes the automatic line insulation tester (ALIT) reports, the faults detected by the router control (live traffic), and the register store routiner (RSR)

The computer output

The new program takes the contents of the paper tape input and sorts it, along with fault patterns retained in its memory and presents them under the following six sections

Section 1

ALIT and RSR PRINTS This is a list of all the RSR and/or ALIT reports. At present these are only printed when specifically asked for by individual exchanges.

Section 2

Analysis results All the exchange faults reports are sorted into individual faults and assembled into 'blocks'. A block will be printed if it consists of a minimum of 8 (if not the faults are retained in the memory). If the total number of faults in any one block is more than 25 then the last 25 are reproduced and the total number involved printed at the end of the fault block. Each fault block is also given a priority category from one to four, which is related to the date of the last printout, so giving an indication of which printouts should be looked at first.

The fault blocks are printed one to a page to assist in faulting and filing and a reference to a routine is also made with each fault block. The routines are a guide in the location of faults and are of particular use to maintenance staff who are new to the TXK1 system. At present not all of the routines have been written but they will be published in due course.

Section 3

Identity failures These are a presentation by the computer, under specific headings, of printouts which have identified one or more items of equipment as missing

This is a new type of output from the computer and presents information to the maintenance staff such that failures in the fault data collection circuitry are brought to their attention. It prevents the need for manual routines to check that the circuitry is working.

Section 4

Error analysis results These are printouts which, because they are not in the correct format, have not been accepted by the computer as valid. Examples of the errors are reproduced together with the total number of invalid records in each category.

This section thereby monitors the operation of the equipment monitor, teleprinter control, teleprinter, and perforator without the need for manual routines.

Section 5

Switch identity routine This section is printed out every 13 weeks. The printout gives a list of the crossbar switches which have not been identified to the computer over the last 13 weeks. The fact that a switch appears in this section does not in itself mean there is anything wrong with its operation, but if the same switch appears on two or three consecutive outputs then the circuit which stores the switch identity is worth checking. This output from the computer reduces the switch identity circuit routines to about five per cent of that which would be required if it were all to be done manually.

Section 6

Statistical summary This section gives a graphical representation, over a rolling yearly period, of the inputs to the computer broken down into the various fault types on a monthly basis. The fault types are also represented as a percentage of the total input. The exchange maintenance staff will therefore be supplied with a means of monitoring the overall trends in the exchanges fault types, and numbers of faults, without the need to collect the data themselves.

A summary of the above information will be supplied to the regional headquarters of the exchanges in their region every three months.

Experience so far

The improved computer program has brought to light a number of interesting points, some of which are listed below

- The number of fault blocks produced in some exchanges has been noticeably higher than expected, the computer output often showing the same fault on several consecutive runs.
- A large number of exchanges are still having false printouts which could be cleared if work specifications are implemented.
- The number of faults in any one category vary considerably from one exchange to another, the reasons usually being due to specific problems which need special attention.
- Junction marker seize fail printouts due to congestion have been known about for some time but the new program has shown just how widespread the problem is. THQ are now taking further action to try to solve it.
- One of the more important discoveries has been the high level of identity failures (section 3). These have come to light because of the change of emphasis in the method of sorting the fault printouts inherent in the new programme, the maintenance staff not normally picking up these faults as they are trained to look at what has been printed as against what is missing.
- The switch identity routine, in a similar way to the identity failure, has shown several omissions from the fault printouts, whole routers and distributors in some cases not providing any printout information at all even though faults did exist. Once the omissions have been pointed out by the computer, the faults have not been difficult to find.

Conclusion

The new computer program is providing maintenance staff with a more logical indication of the persistent or obscure faults in the exchange switching and data collection equipment. It is minimising the effort required in some manual routines and therefore, irrespective of exchange size or printout level, is a useful tool in the maintenance of a TXK1 exchange.

Sv6.4.4 (01-432 1392)

Submarine cable systems–Test data now computerised

by **John Scott** NP 5.2.3

This article describes how computerisation is assisting maintenance on the new UK-Belgium 4 system

The increased bandwidth of new submarine cable systems means relatively large numbers of measurements to maintain the high transmission standards demanded. For this reason, and to achieve the constant surveillance necessary, computerised equipment has been purchased. The first of these was installed for the 'New Generation' (NG 1) system between St Margaret's Bay (Dover) and Veurne (Belgium)

Data-link

Basically, both terminal stations contain identical surveillance equipment which includes computers interconnected by means of a data channel. This link may be routed separately from that being measured. Additionally, the UK station has a tape punch connected to its computer output. The data channel enables the computers to communicate with each other when calculations based on measurements at both terminal stations are performed.

The measuring equipment can be connected – by means of a co-axial switch – to one of six trunks terminated at different monitor points in the wideband transmission equipment (test points 'C', 'E', 'F', 'H', 'J' and 'K' in the figure). Two other trunks ('A' and 'G') are permanently cabled to the inputs of the system to allow the injection of test frequencies from the computer-controlled test equipment.

Because a submarine cable system carries both directions of transmission over a single co-axial cable, a frequency translation process is used to separate them. The input to the NG 1 System, from the inland ends, is Mastergroup assembled traffic carried at baseband in the Belgium-UK direction, and transposed into the lower cable frequency band in the UK-Belgium direction.

The repeaters contain two oscillators which generate supervisory frequencies in the high and low cable frequency bands, and these are used for performance measuring purposes.

Measurements

The computerised surveillance equipment is capable of measuring:

- the frequencies and levels of the supervisory frequencies at test points 'E' and 'J' (see fig)
- the Inter-Mastergroup frequencies at test points 'C', 'E', 'F', 'H', 'J' and 'K'
- the system pilots

When necessary, data is exchanged between terminals thus giving each station the results from the distant end.

Computer processing

Specially developed programs have been written to allow the use of RAMIS (Rapid Access Management Information System) on the IBM computer at Harmondsworth, from an on-line data terminal operated by NP 5.2.3.

The paper-tape punch at St Margaret's Bay – previously referred to – produces a tape of the measured data in a form acceptable for feeding into the RAMIS system. The tape is mailed in special boxes to Harmondsworth where it is held in temporary RAMIS store. NP5 then use their on-line terminal to request a print out of data from the computer. If the information is valid, RAMIS is instructed to load it into permanent data files for future use.

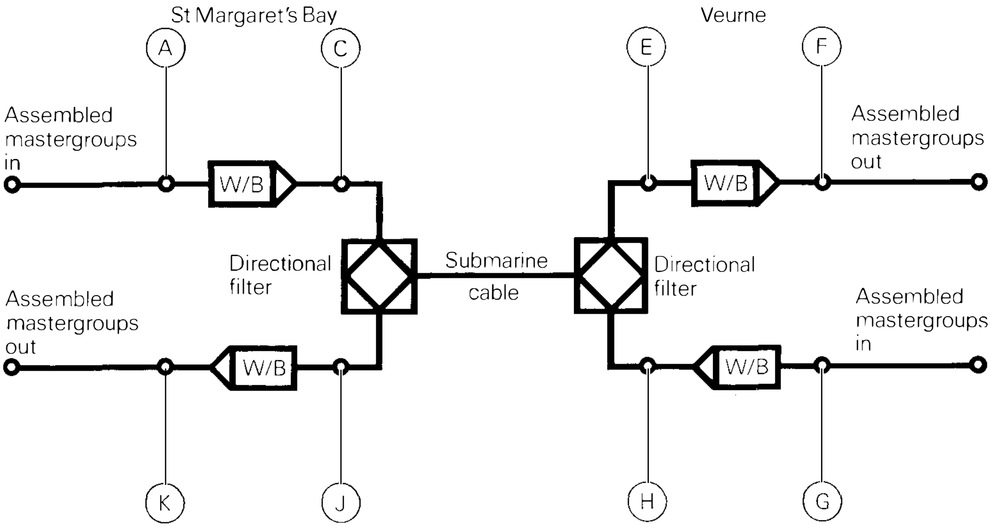
Data can be accessed either in the form of tables, or in graphical form. An automatic graph-plotter at Martlesham can be instructed to produce specific graphs needed for long-term assessment of submarine system performance.

Use of graphs

Temperature variations of the sea cause changes in the attenuation of submarine cable systems. Variable temperature equalisers (VTE) are provided to compensate for the annual variations.

In the past it was necessary to manually plot graphs of these variations so that trends could be established. Other terminal networks could then be adjusted, if necessary, to make certain that the VTE would provide adequate compensation throughout a complete temperature cycle.

The St Margaret's Bay-Veurne system differs from previous systems in that the repeaters themselves are designed to be self-



Block schematic of test points St Margaret's Bay – Veurne System compensating. Changes of sea temperature alter the repeater gain, overcoming the effect of the changes in cable attenuation. The new computerised method is able to plot graphs to show how effective the repeaters are in achieving this aim. In practice some cycling will be observed due to uncompensated end-sections and other residual effects, but these are corrected in the terminal stations using VTEs and attenuators. Because the measuring points for this particular test are on the submerged cable side of the correction networks, the shape of the graphs is not affected by the terminal changes.

Other uses of the graphical plotter at Martlesham are:

- observing the effect of inserting extra lengths of cable during repairs
- measuring the performance of selected repeater sections
- terminal station measurement
- variation of noise level with time on the cable system

The future

The new system has set the trend for data processing in the sphere of submarine cables for years to come, but other ideas are being considered:

- Results from future systems may be extracted from the terminal stations using magnetic tape cartridge or cassette – replacing the paper tape method
- RAMIS may be used to process the results from existing 5 MHz and 14MHz submarine systems. The provision of computer-controlled test equipment at these stations would undoubtedly ease the processing operation. Many factors, including space availability and cost, would need assessing before this became a possibility.

NP 5.2.3 (01-432 1451)

Teach-yourself elementary electronics

by **David Paice** TP7.1.2

The MTR training project team at Glen Parva RETC (Leicester) have produced the prototype of an exciting teach-yourself training package – the 'Parva Pak'.

With the increasing penetration of electronic equipment into TXS exchanges and the introduction of TXE, an extensive retraining programme has been planned for staff with a purely Strowger background and little or no electronic experience. A self-contained training package has been produced, as first introduction to basic electronic principles. If successful, this package will be made available to all regions.

Portable package

At an early stage it was decided by the project team that the package should be portable to enable the student to take the course at a location of his choice or in private, as some people may be reluctant to admit their need for elementary electronics instruction before going on a formal training course. A teach-yourself package would also enable the student to work at his own pace and repeat any aspect of the course that presented particular difficulties. The package is battery-powered for safety's sake – compact for ease of carrying and strong enough to withstand constant use and transportation.

Facilities of the training package

In consultation with Stone POTTC, the project team determined what would most assist students in preparing for attendance on their first formal electronics course and it was decided that the package should give instruction on:

- Ohms law;
- Resistance, current and voltage measurements;
- The resistor colour code;
- The use of potential dividers;
- The function and characteristics of a diode;
- The function of diode AND/OR gates;

- The construction, uses, and characteristics of a transistor;
- A simple single-stage amplifier, astable, bistable and monostable multivibrators, spike generators and time-constant circuit;
- The function and uses of zener diodes and thyristors.

Fig 1 shows the resulting prototype, and fig 2 the component symbols with their associated jack-in terminals. All components are mounted under the face plate, along with the battery power supply, and can be interconnected with flexible plug-ended leads. The meters allow simple tests to be made. The face plate, components and plug-in leads are contained within a double-sided executive briefcase, which has an automatic power cut-off on closing.

Also housed in the case is an A4 folder containing the training programme which the student uses to go through the course, step-by-step, at his own pace. The folder also includes a set of 34 experiment result sheets for completion by the student.

Validatory success

After constructing the package and completing the programme book the teaching unit was validated by 16 students of different ages. Whereas half of the students achieved less than 15 per cent on the pre-test, over three-quarters attained more than 80 per cent on the post-test. The experience of working with the package was enjoyed by nearly all of the validation group, finding it easy to operate and understand.

This group of students thought the package useful for those who require an understanding of elementary electronics. Several of the suggested minor improvements to the equipment and programme text have already been adopted and others are being considered.

A very limited supply of the 'Parva Pak' is now available to areas at present but plans to extend its availability are under consideration with POEU and SPOE.

TP7.1.2
(01-432 5262)

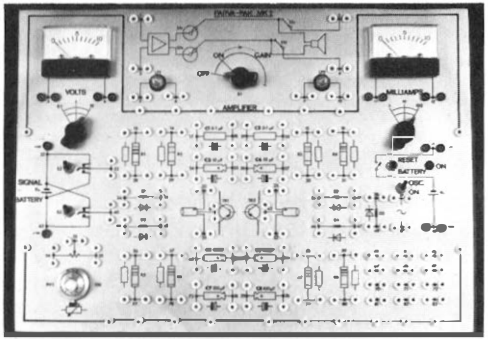


Fig 2 Parva Pak face plate

Fig 1 Complete course package

The negative impedance repeater– Does it cause switching problems?

by **John Ford** SETR

The junction network between local exchanges and their parent GSCs employ different types of signalling system – Loop/Disconnect, DC2, or PCM. Between GSCs, AC signalling systems are used. Problems arise when dependent exchanges and GSCs are interconnected with circuits amplified with Negative Impedance Repeaters (NIR) and employ loop/disconnect signalling. This article expands on some of the problems found on outgoing junctions; a future article will deal with incoming junctions to TXK1 exchanges.

The problems

Following investigations by maintenance staff into reports of poor service, a common denominator was found. Junction circuits outgoing from dependent exchanges to Strowger GSCs, fitted with NIRs and 2-wire attenuators, and routed on 0.63mm (101b) cable, appeared to be the culprit. Two problems were unearthed on these circuits:

- Calls dropping out on 'called sub answer' (CSA)
- Calls dropping out at one of the switching stages in the GSC.

The question asked was – had the junctions been planned correctly?

Junction planning limits

Dependent exchange outgoing junctions are planned to TIs *A5 F0025* and *A5 C1015*. 2-wire repeatered circuits are covered in *A3 C1051*.

The junction resistance limit for most modern equipment is 2000Ω. Until recently, TXK1 exchanges had a D and I relay loop excess of 400Ω bringing the limit down by 500Ω. This limitation has been removed by the implementation of Works Spec no TE30087 which brings the D and I loop down to 400Ω.

A second limiting factor is whether the terminating end of the junction can be switched to a capacitor-type transmission bridge (as opposed to an inductor type). If so, a further 250Ω reduction is called for, bringing the TXK1 outgoing junction limit to 1750Ω. Most GSCs will have some, if not all, capacitor bridges so the limitation occurs in most places. In fact it might be better to make the limit 1750 and lift it in the few cases where capacitor-type bridges are not involved.

Two other factors need to be taken into account:

- If the junction resistance is approaching the limit, test call sending from a dependent exchange to a GSC needs to be carried out to a test number on another dependent rather than on the GSC itself. This is because the A relay on the outgoing relay set at the GSC is reverse fluxed when the line current is reversed on CSA, as opposed to a final selector A relay which is not. The A relay current will be reduced by about 2mA due to the introduction of the D relay at the outgoing end when CSA occurs. If the junction is over its resistive limit this current may be insufficient to hold the relay in.
- Where junction resistance is high, and

Equivalent circuit of a typical junction using negative impedance repeater and 2 wire attenuator

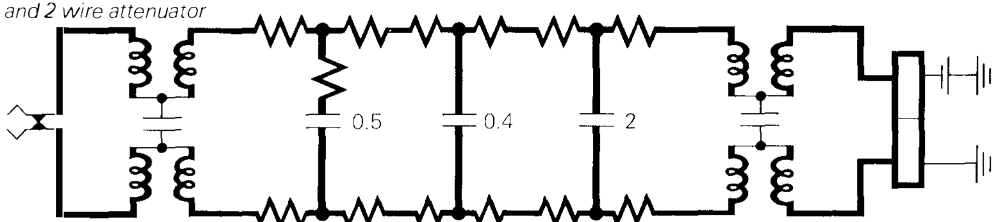


Fig 1

test call sending is carried out to a GSC, a test number which involves WS switching on the final selector should be used. This introduces a further 200Ω into the circuit, thus testing the junction under the most stringent conditions.

Transmission considerations

Calculations* show that there are considerable differences in the effective resistance and capacitance between a typical line just in the 3dB limit without an amplifier, and one which is outside the limit but with amplification to give a comparable overall loss.

In the non-amplified case, with standard loading, the current in the A relay of the incoming selector (200 + 200Ω) is typically 37.24 mA before CSA, and 32.4 mA after CSA. Whereas, in the amplified case the current could be 25.46 mA and 23.1 mA respectively. Additionally, the capacitance of the junction will have increased *nearly ten times* to 4.9μF. The figure shows the equivalent circuit of an amplified junction, whereas a non-amplified circuit would be equivalent to a pair of wires.

The A relays of the outgoing auto-auto relay sets at the GSC are 75 + 75Ω and will have to work to a wide range of inputs from amplified and unamplified junctions on both 0.63mm and 0.9mm cable. Are they routine tested correctly to allow for this? To achieve the equivalent of the 'in-service switching network' an RC network is required in the routiner pulsing loop.

*Anyone interested in the detailed calculations should contact the author.

Factors contributing to service problems

- Some NIRs (Amplifiers 173C) were unstable at low gain settings, resulting in the amplifier being used on a higher gain setting with a corresponding increase in attenuator value after the initial circuit specification was drawn up – this put the circuit outside its DC limit in some cases.
- The NIRs are usually installed at the TRS in the GSC, while 2-wire attenuators are installed at the dependent exchange on a transmission rack, quite often the only one in a predominantly 'auto' environment.
- Because the circuit for the attennuator is in the RP/RPW series (possibly the only such diagram in that series at the dependant auto exchange) there is a good chance it will be filed at the back of the drawer and forgotten.
- Although they have been in service for a considerable time, it is only fairly recently that many staff have become aware of 2-wire attenuators.
- The planning TI *A5 F0025* is lengthy and complex. A reissue clarifying the planning rules is now under consideration. As it is, staff could be forgiven for planning a junction outside permitted limits.

What are the answers for outgoing junctions?

- Apply the correct DC limits
- The A relays of selectors and auto-auto relay sets must be in good adjustment to accept pulses from junctions with a wide range of resistance and capacitance values.
- Banks and wipers must be of an acceptable standard.

A final question

Cases of 'buzzing' relays in the outgoing relay set of the second half of tandem links are known of. Is the high capacitance (about 5 μF on NIR circuits) of the first link responsible for this? Does anyone know of a cure?

Are there any other unsolved problems? SETR/SM1.2 (0273 201734)

Those replacement diagrams....

by **Alan Wood** Sv6.5.6

THQ have frequently received complaints from field staff about the poor quality of diagrams received from PO Reprographic Services (RS). Even when diagrams are returned with a complaint a second copy is sometimes still poor. Many factors contribute to this problem but THQ has formulated a revised procedure which should ensure a more satisfactory service.

Although RS will keep a close watch on the copies produced, it is inevitable that a few poor quality prints will still get through. If so the poor copy should be returned to RS with a covering note indicating the actual defects. RS will then produce a replacement copy under close surveillance. Should this copy still be unsatisfactory RS will then arrange for a new microfilm or a new diagram master to be obtained. In the meantime, a poor quality copy (if not too bad) will be returned to the field, suitably annotated.

Obviously, the replacement procedure will take time but the new arrangements will speed up the process. Nevertheless, where a poor quality diagram does result, its quick return to RS is the only way to ensure that an adequate service can be provided

What you can do

These guidelines will assist in smoothing the flow of requisitions:

- First, it is recommended that *TI K5 A0401* be made available to all staff responsible for preparing requisitions. Staff should be familiar with the contents.
- For diagrams and drawings, use form A1147. Only one copy need be prepared in *black* ink for each diagram or drawing. (For multi-sheet diagrams see note on A1147)
- Do *not* enter the issue number – the latest will be sent.
- If a superseded issue is required, use form A1147 but insert the entry in *red* ink including the issue number. (See TI *E6 A0203)*.
- It is the originator's responsibility to ensure that the correct details are inserted onto the requisition. For example, if diagram AT/ATW 613100 is required then that title *must* be inserted and not AT 613100 nor ATW 613100. Neither of these titles are listed in the document which RS staff refer to. A requisition with an incorrect title, however minor the error, will be returned stamped 'not filed'.
- The address panel of the requisition must be adequately and clearly completed. 'O I/C, ATE, Blanktown' is inadequate. Rubber stamps are acceptable only if properly inked and clear. Inadequately inked rubber stamps are frequently used but, irrespective of the accuracy of the requisition, if the address is not clear, RS staff cannot do their job effectively. Such requisitions may have to be delayed or even disregarded owing to the volume of work on hand.
- All requisitions should be signed in full. If RS needs to refer back to the originator, initials are of little use and therefore unacceptable.
- Variations of diagram size are not practical for general issue, except for training school use. Incidentally, it is only microfilmed diagrams that can be varied in size; dyeline diagrams cannot.

Bearing in mind many millions of copies are produced annually by RS, the service given is basically satisfactory. RS wish to assure continued and improved satisfaction, and these new procedures correctly applied by everyone will help to achieve this objective

Sv6.5.6
(01-432 1342)

Bridge that gap!

John Clare of TMS4.6.1 asks.......

"Will modern switching and transmission systems, which use solid-state components, lead to a loss of adjustment expertise which, for so long, has been a necessary skill of the maintenance engineer?"

An official report recently caused me to suspect that if this expertise diminishes, staff will need to work to much wider tolerances in future. It stated *"It was found that the residual gap of the 'A' relay had diminished to nine miles."*

THQ/TMSD have so far not received any authority to investigate and find the best method of measuring such gaps or whether EEC regulations require a metric/imperial conversion table".

– For the benefit of the 'newer' boys who may never have to handle feeler gauges or tension gauges, a MIL is synonymous with a THOU, or 0.001." (There are 570.24×10^6 *of them in 9 miles!) – Editor.*

....On the 'Secrets of Line 6' as revealed in MN12

I must not let this subject pass without comment. Firstly, it is true that basically the transmitter is cheap and nasty as it ever was. Surely in this day and technological age customers should not have to depend on carbon granules stuffed in a box! Would so many be changed if it was more difficult to do so? Because a customer expects something done after he has reported a noisy call from someone in the same area, the transmitter is changed automatically! Listen to a 'phone-in' programme – at least 5 per cent are noisy even in good weather! Even our local live wire on BRMB knows the advice to give – "clout the thing you speak into; your carbons need a shake up!" Very technical, but sometimes effective. And another thing, you say telephones are changed to clear faults – are they, or is that what the customer wants? Or, are there plenty of telephones in stores but no receivers, dials, cords etc? Who designed the switchhook on the 746? What about the Trimphone disaster before the regulator 7A? – I could go on.

Why don't you all come down to the sharp-end – where the customer is? Who knows, you may even learn something.

G T Powis
MTR/EMN.1.6 Birmingham

Dave Manning (Sv5.2.3) replies:

It is a fact that carbon insets, genuinely faulty when changed, quite often prove OK on subsequent test. A new inset is likely to avoid that sort of thing – but it will take time for staff to get confidence in it before fewer insets are changed in the interest of PO-customer relations. There is an awkward fact, however, that overall averages show that 'line 6' results are worse in Strowger than common-control exchange areas. The favourite explanation for this has to do with wiper-to-bank contact resistance and noise. Overall line 6 results being highest in regions with the largest cities seem to point the same way.

Our job was not that of giving reasons, but getting numbers. Opinions are not enough. What it wanted – if it can be got – is statistically convincing evidence. Even then, there would remain the knotty problems of deciding when, and when not, to send faultsmen and of reducing or stabilising wiper-to-bank resistance.

Incidentally, some of us are not without field experience!

.....on telephone billing

Mr W H Bleach of LTR asks: "How is it American telephone bills detail the charges for every call made, while the British PO just give an unqualified number of DMU's?" I am a Special Investigation Officer and am often asked such questions by customers.

Can anyone tell me, please, how for example the US Bell system produce such detailed statements, and whether we intend improving our billing to match the Americans?

LTR Ea EM121

....about the connector dropwire no 2A

I think someone in THQ is trying to pull the wool over our eyes! Surely the new connector, dropwire no 2A is the same as 'scotchlocks' we used in the mid-60s. These did not last long and were often the cause of 'noisy' and 'no dialling tone' faults. They were always in an advanced state of decay. We don't want them again thanks! But let me offer a suggestion – either fill them with grease or withdraw them, otherwise they won't be any better than the other connector with four screws and snap-on-lid, wrapped in Denso tape.

At present we use copper nibs and blue sleeves and these work fine. It may cost a few coppers more, is not very smart, is not in the TI – but it works, and lasts for years! Finally, to be constructive, we are trying out the new connector and a nib and blue sleeve on the same dropwire. I will let you know which fails first.

Rodney Norman
M2.3 Tunbridge Wells

Sv5.1.1 replies

Similar items to the connector dropwire no 2A were investigated but were unsuitable for jointing conductors of various gauges, they proved unreliable in damp situations, and were unsuitable for aluminium conductors. Although Mr Norman is right in pointing out that the first deliveries were dry, all new supplies will be grease filled for additional protection.

The method of jointing using sleeves may lead to future disconnection faults because the dropwire has to be stripped, which may result in wire nicks.

Arrangements have already been made in two regions for a number of grease filled connectors to be installed and evaluated.

.....On external plant reliability

Articles on System X philosophy suggest an improved level of customer service. But in my experience as an RSC AEE, most causes of complaint lie in the external plant. For example, Cable, Dropwire.

This was introduced in the early 1960s for cheap provision and renewal based on low labour costs compared with today. It has a limited life. Why not provide a customer's feed that will serve the life of the property like gas, water or electricity?

Dropwire is not the integrated package it should be; there is no cleat for it, and no reliable connector. It will not fit the BT 41 without being stripped-and the result of that is well known!

Let us abandon the present piecemeal approach towards external plant provision and make sure that the potential reliability of the equipment for switching calls can be matched by that of the line plant.

A R Dodding
Bradford TA

Sv5.1.1. replies

Mr Dodding's observations are well appreciated and much has been done already to implement a new local underground maintenance strategy. The objectives are to reduce within the next 5 years, the UK fault rate from 0.126 to 0.07 fault reports per working circuit per annum, and to achieve a 95 per cent TIP2 target (% faults cleared by end of next working day).

A similar strategy is being prepared for the O/H network.

To answer the general points on cable, dropwire – many of the problems are due to obsolete type dropwires (for example, no 3) and incorrect practices, such as construction in line of route without sufficient clearance between wires. A new cleat is being investigated by VA Branch. See previous letter on the recently introduced connector, dropwire no 2A. With the exception of dropwire no 4 there is no need to strip wires when terminating on BT41s (TI A2 H3557 refers).

.....on 'Cinderella' exchanges (TXK1)

Has THQ forgotten about the maintainers of the PO's Cinderella exchanges (TXK1) and moved to higher things – TXE4? Before we are obliterated completely from their memories, how about action on some of our problems which have been around for ten years? For example:

- *TI A6G1031* (para 4) states that lines can be restored from OCB and ICB with links. Yet the only method of obtaining these is to beg, borrow or steal them during installation work.
- Much is made of the equipment being dust-sealed. It is, until the shelf covers break. But we cannot obtain these or inter-rack space doors except by the above-mentioned method. When will they become available?
- What happened to the electronic subs-controlled transfer equipment featured in the *POTJ Vol 26 no 3?* The present equipment has severe limitations.
- Are we ever going to see a replacement for the archaic printer no 2A?

G Brown
Coventry Area Binley ATE

Sv6.4.4 replies

We can assure Mr Brown that he is not among the ranks of the forgotten men. Statistics show that TXK1s give an excellent service to the public, better in fact than any other system currently in use. Obviously this reflects great credit on people like him – in spite of the frustration felt. We only hope those feelings have not affected the quality of work. Now, for the points raised in Mr Brown's letter.

- *We expected the initial provision of Red and Green links to last the exchange life. An order has been placed for more and you will be advised when they become available.*
- *It is difficult to see how shelf covers and inter-rack space doors become broken. We don't believe it is a national problem. If it becomes one, we will stock replacements. Our advice for the present is to place local orders with the contractors.*
- *You may already know that a field trial of the electronic subs-controlled transfer equipment was started in December 1978. This followed unfortunate delays with modification to earlier equipment. If all goes well this equipment will be available by mid-1980.*
- *The problems with the printer meter check 2A are well known – stemming from its Strowger origins. It is hoped that a replacement will be obtainable before long.*

We hope these answers will help convince you that THQ are still concerned with TXK1 maintenance problems.

The old way

This caption on page 15 of MN13 prompted C R Sykes AEE, Guildford (M18) to complain.

"I was not impressed with the picture showing an engineer checking the SG of a cell, using an hydrometer, *not* wearing eye shields and gloves as he should. (Look at the state of his apron!)".

Jim O'Connor informs me that you are the only person to write in pointing out the 'deliberate mistake'. This means either the photograph accurately portrays the bad practices unconsciously accepted by most, or that his article wasn't read! Thank you

Mr Sykes for being on the ball. (TI E12 F0011) describes the correct working practices) – Editor.

And another on the same topic

The article on Battery Maintenance in *MN13* states that the meter, Multirange 17A is used to "read cell voltages to an accuracy of ±10µV." To achieve this would tax even the best standards laboratories in the country. My own laboratory – which is BCS approved – has a measuring capability to an accuracy of only ±28µV in the voltage ranges 2.22 to 2.3 volts as mentioned. To measure such voltages the '17A' has to be used on the 10v range on which it has a resolution of only 1mV. If this is added to the claimed accuracy of ±(0.05% of reading ±0.01% of range) the uncertainty of measurement becomes µ3mV, which is 300 times the µ10 V stated!

Although the meter, Multirange 17A is obviously ideal for battery maintenance needs, MN readers may well think the meter is more accurate than it really is and requisition them for other purposes".

M W Cartwright, PO Electrical Calibration Laboratory, QA Branch, Birmingham (British Calibration Service Approved, no 0075).

Maintenance News aims to provide a medium for two-way communication – that is, between Headquarters and the field. If you want to write about anything you may have seen in *Maintenance News*, or indeed, about any maintenance topic, send your letter to: The Editor, Maintenance News, Room 4089, Tenter House, Moorfields, London EC2Y 9TH. Say what you like, but the Editor may tone comments down if he decides to publish. Do please give your full address.

If you have a contribution to offer to *Maintenance News* other than a letter to the editor, please forward it through normal channels to the *Maintenance News* agent for your Region or Telecommunications Board. The list is shown below. The editor cannot publish anything to do with current awards suggestions.

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