Maintenance News

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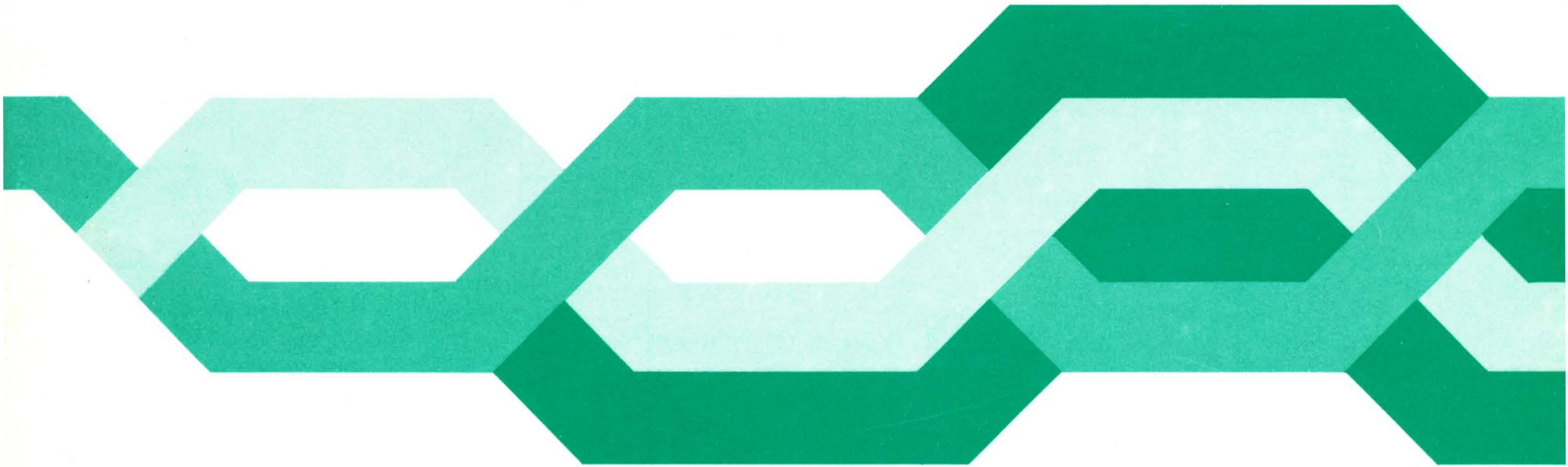

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Keeping up the pressure

by **Joe Turner,** Sv5.1.2

Currently on field trial is a new technique which enables air pressure to be maintained in a defective length of underground cable while its replacement is provided.

When a sheath defect develops on a length of pressurised paper-core cable, internal air pressure – maintained either by equipment in the exchange or a temporary source more local to the defect – normally prevents water from entering. But with established practice, when the joints at each end are opened to connect its replacement, pressure is lost in the faulty length. If the defect has occurred in a waterlogged duct, insulation faults can then easily occur, possibly putting all the pairs in the cable out of service.

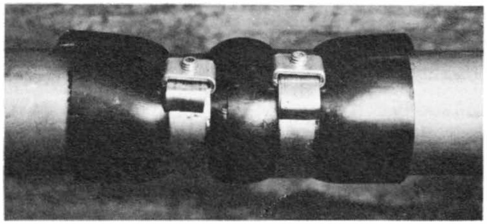
Our new method – Experimental Changes of Practice Committee field trial (ECOPC2) – is to supply fresh air to the *defective* length from a local source while constricting the sheath at points each side of the fault so as to force the flow of air towards it. This prevents the ingress of water at the fault while the joints are opened and a new length is connected using a 'no-break' change-over method. The constriction technique has been used successfully on main, junction and local cables with both lead and polyethylene sheaths.

How it is done

Air valves (no 1 or 5) are fitted to the sheath of the defective length at convenient points. Usually these are at the jointing chambers at each end, between the joint which has to be opened and the duct mouth. This enables air cylinders or portable compressor/desiccators to be connected to the length so as to maintain a pressure of 200 to 300 mbar (three to four psi).

To apply the constriction first a piece of polyethylene sleeve, approximately six inches long, is cut to fit round the cable at each end of the faulty length between the newly fitted air valve and the joint. Two $\frac{3}{4}$ inch stainless steel bands are then placed round each piece of sleeving and, by the use of a tensioning tool and a torque wrench, a tension of 10.85 Nm (8 lb ft) is applied to compress the cable. This increases the pneumatic resistance at these points (restricts the air path between the cable pairs) sufficiently to enable the required pressure in the faulty length to be maintained. The joints are then opened and the renewal work completed.

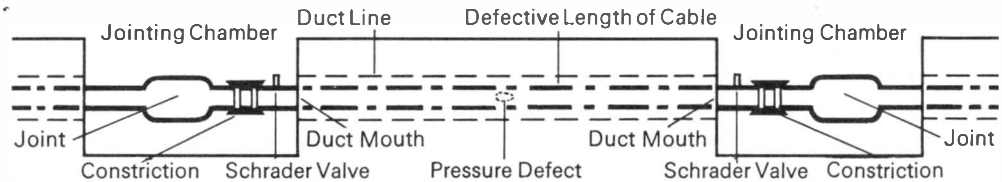
The constriction applied



At the moment the technique can only be used on cables containing more than 100 pairs. Also, working space is needed in the jointing chamber to manipulate the tensioning tool and torque wrench. If there is unsufficient space the constrictions could be applied at pull-through points provided they embrace the point of defect and the local air source.

Among the many successful operations so far has been the renewal of a length of composite cable (containing both coaxial and audio pairs) although the coaxial pairs were made spare before the constrictions were applied.

Sv5.1.2 (01-432 1310)



Constricted Cable ready for change-over

Call offices—customers and complaints

by **Dave Popham,** Sv5.3.5

The statistics show that we are now giving a better Public Call Office (PCO) service than we were five years ago – 15 fault reports for each PCO every year as against 24 in 1973. But despite the skill and effort put into PCO maintenance public opinion of this service is still very low. Where are we going wrong?

There are three crucial factors in PCO maintenance:

- The way we compile our statistics
- Our ability to localise faults
- The speed with which we clear faults

For ordinary telephone lines we monitor the number of fault reports per station per year and the time it takes to deal with them. Each fault usually inconveniences only one customer. If he suffers too many faults or we take too long to clear he hammers on our door with facts and figures. With this constraint upon us we can quite reasonably ignore second and subsequent reports about one incident and our statistics will accurately reflect equipment performance.

Each PCO fault, however, is likely to affect many customers. (The current *complaint* rate is about 115 per PCO per year). None of them knows how long we take to clear it; none of them knows if it is the first or 101st this year; so they can't present us with facts and figures. They just form a low opinion of PCOs. Under present procedures, treating PCOs like ordinary lines and ignoring second and subsequent reports received in the Repair Service Control (RSC) we conceal the only true indication of our standard of service to the public – the number of complaints they make.

Some 75 per cent of the complaints we receive relate to 'cut-offs' – those failures in the signalling dialogue between the coinbox and coin and fee check relay set (C&FC) in the exchange. Experience shows that 80 per cent of field visits to coinboxes on such complaints would result in RWT. So, currently, we use a system of filtering in the auto-manual centre (AMC) which requires that about five complaints of 'cut-off' are recorded against a PCO before a report is made to the RSC. This procedure gives a reasonable assurance that the fault is in the coinbox rather than a C&FC and is essential if we are to avoid a demoralising waste of the field maintenance man's time. But it also means that four out of five 'cut-off' complaints do not reach the RSC; only the fifth one gets counted – always providing that no other report on that PCO is 'in hand'. So although this is done from the best of motives, it causes us to hide the truth from ourselves and widen the gap between our own and public opinion of the service given by PCOs.

Apart from routine testing in the exchange we have no direct means of recognising a faulty C&FC. References from the field to the exchange are only made after a number of RWT visits to coinboxes, when it becomes apparent that something may be wrong in the exchange. C&FCs are pretty reliable but when they *do* develop a fault the number of call failures caused can be enormous. A faulty C&FC is seized hundreds of times each day by many different coinboxes. This means hundreds of dissatisfied customers and of these one in five complain.

Finally, the longer we leave coinbox or C&FC faults uncleared, the larger will be the number of customers who will encounter failures.

So what can be done about converting thoughts in action?

Our best hope lies in a new complaint handling system for PCOs known, inevitably, by the number of the form it uses as the *'T 1284 Procedure'*. It is currently the subject of ECOPC3 field trial 565 and, excepting LTR and Scotland, involves one AMC in each region.

The form consists of two sheets – A and B. It is merely a log kept in the AMC and replaces the present T222 form. It is very easy to fill in, being merely a stroke record of complaints as they are received. As the stroke record builds up, both coinbox reports and C&FC reports are generated automatically. Complaints relating to defects which are quite clearly due to the coinbox are merely logged with a stroke and passed to the RSC immediately.

Here's how the form is used.

The A sheet comprises a list of PCOs in exchange and number order. Each PCO has the exchange terminating equipment shelf code listed against it. For each PCO there is a box of squares for entry of 'cut-off' complaint strokes. The number of squares for each box is related to the use rate of the PCO. A full box generates a coinbox report to the RSC.

The B sheet lists shelves of exchange PCO terminating equipments in exchange and shelf code order. Against each shelf is a box of squares. For each complaint logged on the A sheet a duplicate stroke is entered in the appropriate shelf box. A full box generates a C&FC report to the RSC.

Since each shelf of terminating equipment (for 25 coinboxes) is served exclusively (in Strowger exchanges) by a small number of C&FCs, we are, on the B sheet, logging complaints against these C&FCs as well as against individual PCOs on the A sheet.

When a cut-off fault occurs in a particular coinbox, complaints will accrue against it on the A sheet. The corresponding shelf box on the B sheet will gain strokes at the same rate but since it has more squares it won't fill up so quickly.

When a C&FC fault occurs, since it is accessed by 25 coinboxes, complaints will rapidly occur in the appropriate shelf box on the B sheet. These same complaints will be scattered among the coinboxes – a few to each in proportion to their use rate – so none of their boxes will fill up as soon as the shelf box in question.

Although the filtering process on the A sheet is similar to the present T222 scheme, its advantage is that the number of complaints required to generate a 'coinbox report' is related to the use rate of the PCO in question. This ensures that every PCO fault gets attention and in a reasonable time. In addition, the fact that the new procedure is also used to generate C&FC reports means that we no longer have to be so protective against C&FC faults causing *false* coinbox reports (RWTs). So the average number of reports required to generate a coinbox report can be lower. We thus get coinbox reports more reliably, more quickly and C&FC reports where previously we got none at all.

Actually, the B sheet yields more information than we have so far described. Further boxes of squares are provided relating to small groups of C&FCs accessed jointly by two shelves and still further boxes for C&FCs accessed jointly by four shelves. The same complaint strokes are entered in these, as they are received, and full boxes indicate second and third choice C&FC faults. This information reduces the time required to identify the faulty C&FC in the exchange.

In exchanges where access to C&FCs is not graded, the C&FC reports obtained are less sensitive and less informative, but the situation is still an improvement on that which exists at present.

Now, what about those statistics?

Three indices are produced from the T1284 form:

The Overall Performance Index (OPI) – Complaints (from users) per PCO per year.

The Coinbox Performance Index (CPI) – Reports (to the RSC) per PCO per year.

The C&FC Performance Index (C&FC/PI) – Reports (to the RSC) per 100 C&FCs per year.

The OPI is a service-based index and is used to monitor the performance of the PCO system equipment as a whole and the standard of maintenance service we attain. It is directly affected by the quality and speed of coinbox and C&FC maintenance.

The CPI reflects the number of faults on coin boxes which affect the public and thus monitors equipment performance and quality (but not speed) of maintenance.

The C&FC/PI reflects the number of faults on C&FCs which affect the public and thus monitors equipment performance and quality of maintenance in the exchange half of the PCO system.

The T1284 procedure offers scope for 'whole system' maintenance instead of the 'coinbox maintenance' we have provided until now. Exchange and field staffs will be able to co-operate in a manner not possible before. The new scheme doesn't prevent faults happening but it will drastically reduce their effects on the public and so improve the service we offer.
Sv5.3.5 (01-432 9178)

Automatic test systems

by **Barry Grimshaw,** Sv5.4.3

The ever increasing miniaturisation-integration of electronic circuitry has resulted in PO equipment where more is packed onto a single plug-in printed circuit board (pcb) than was possible on a whole rack not many years ago. The photograph shows the high density of components which can be achieved. This particular pcb has over 200 integrated circuits (ICs) interconnected by several layers of track. Testing and faulting such complex units is virtually impossible using present methods. But the technology which brings such problems can also be used to solve them. Computerised automatic test systems (ATSs) can now do much of this work for us. Telecommunications equipment manufacturers have been using them for some time as a repair aid and, with the increasing penetration of electronics, we can expect the PO to follow suit. Here, briefly, is how a typical ATS works.

Most of us are familiar with some sort of programmable ATS in the form of a TRT tester or exchange routiner programmed by operating keys or switches. Early attempts to adapt such equipment for testing plug-in electronic units required the use of patchboards as the means of programming for each of the many different types encountered. But one of the benefits which IC technology and minicomputers have brought is making the lengthy setting-up procedures associated with 'patchboard testers' unnecessary. Modern ATSs are programmed by software – making them extremely versatile and capable of being readily switched from testing one type of electronic unit to another.

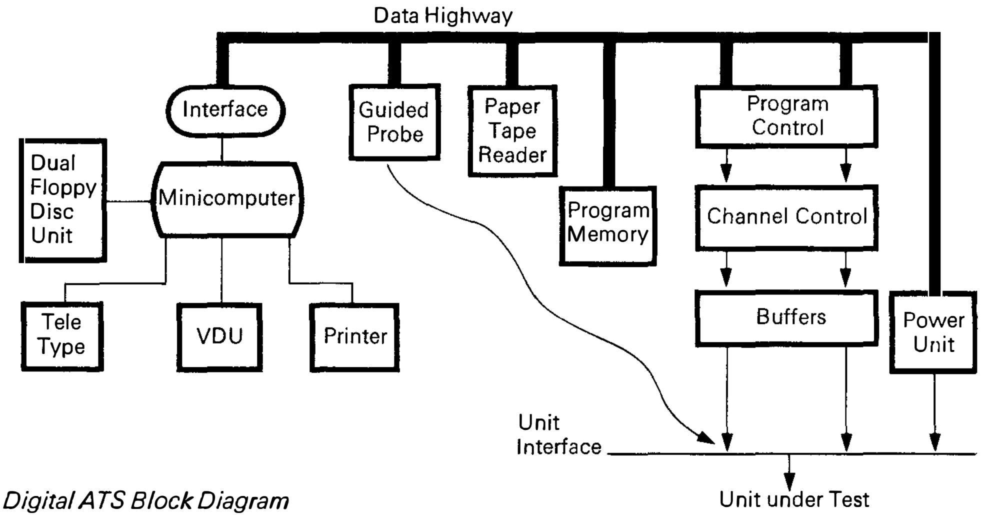
Testing digital boards

The simplified block diagram shows an ATS for digital logic units. Its parts can be grouped into two sections; faulty component diagnosis is done by the minicomputer, the visual display unit (VDU), the guided probe and the floppy disc store (so named because it only becomes rigid when rotated at high speed), while the other parts are used for overall testing. Our second photograph shows a logic unit pcb plugged into the ATS with the probe in use.

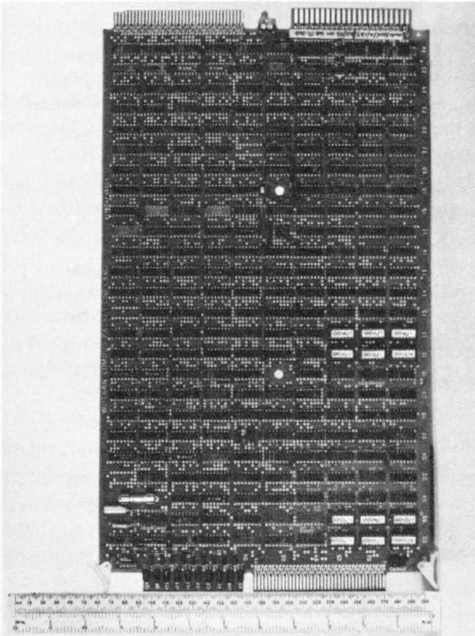
Test programs are written in a simple programming language, typical instructions being to apply a signal (a high or low logic state) to a particluar connection or pin on the board under test.

These instructions are transferred onto punched paper tape and loaded into the high speed program memory *via* the reader.

The program statements are interpreted



Digital ATS Block Diagram



on-line by the program and channel controllers which instruct the buffers to drive the appropriate test patterns onto the pins.

The resulting output patterns are sampled by the buffers and compared in the channel control with those states expected in the test program. Any departure from the preprogrammed values results in a visual indication of the failing test and pin numbers on one of the output devices. The first failing test and failing pin numbers are known as the 'fault signature'. This is used by the minicomputer in the diagnostic section to start the fault locating procedure.

The minicomputer carries out fault locating by using additional data, associated with the particular unit being tested, which is held on the floppy disc store. This data is divided into two sections:

□ The fault dictionary which predicts the area of the circuit most likely to contain the fault.

□ The logic trace data which allows the minicomputer to track in the predicted area until the fault is located.

Both sections of the data for each particular unit are generated automatically as an output from a computer program which is used as an aid when writing and proving the test program.

When locating a fault the minicomputer searches the fault dictionary for an entry which matches the fault signature. If there is only a single entry against the signature, then the dictionary gives the type of fault and the location of the faulty point on the circuit. When there are multiple entries the minicomputer guides the operator *via* the VDU to place the probe on each of the possible faulty areas. Each time the circuit is probed, the test program is repeated and the result compared with the logic trace data. This process continues until the faulty point is located. Because several ICs may be connected to this point it may be necessary to use a pulser and current probe, without further guidance from the ATS, to identify the faulty one.

Testing analogue boards

An ATS for testing analogue units is similar to that shown in the block diagram except that the channel control and buffers are replaced by a common highway which feeds programmable instruments such as function generators, power supplies, counters and so on. The outputs of these intsruments are routed to the unit under test *via* a reed relay switching matrix. Under the control of the test program these drive and monitor signals associated with the unit being tested. As before, the measured values are compared with preprogrammed values to provide a pass or fail decision on each test. But, unlike the digital ATS, fault location is achieved by accessing many points within the circuitry of the unit simultaneously. Because of the lack of access to discrete components on analogue units additional 'unguided' probing may be required to identify the faulty component.

ATS construction

While early ATSs were quite large – perhaps as many as four racks of equipment – modern systems resemble an office desk – as the photograph shows. They are modular in construction to allow buffer capacity to be expanded for testing different sizes of electronic units. A wide range of buffers is available to cater for the different logic families with test pattern generation speeds up to 8 MHz. This last option allows for high-speed testing of units containing microprocessors, memories and so on.

For both digital and analogue units access is normally achieved using an appropriate edge connector. In some cases however, especially with analogue units, it is necessary to access circuitry within the unit and this is achieved using a pattern of spring loaded needles. This arrangement is known as a 'bed of nails' jig and involves creating a vacuum between the unit and the jig so that the needles make connection with uniform pressure onto the solder tracks of the unit.

Conclusions

With the current trend towards digital transmission and switching, the present low penetration of complex digital units will increase steadily and will eventually form a substantial proportion of PO equipment. In the past this low penetration – consisting mainly of specialised and very advanced systems – has not warranted general PO involvement with repair; it was expedient and more economic to use the manufacturer. Faced with the problem of testing these units for both production and repair all the major telecommunications manufacturers opted for ATSs and have been using them for some time. But as the penetration of digital systems increases, we can expect ATSs to be introduced for PO use to aid repair of these complex units. We are confident that our action will assist staff when carrying out future repairs and help them to keep abreast of this rapidly advancing electronic technology.

Sv5.4.3 (01-739 3464 x321)

Training—a £47 million investment in 1976/1977

By **Ernest Truslove,** TP7

What do you need for good maintenance and good service to customers?

Trained staff. Right, anything else?

And transport. Right again.

And instructions, diagrams, test gear and spares. Quite.

And transport maintenance staff. Carry on...

And training for transport maintenance staff.

Do you know that we have just opened a new MT school? It has been built near Duncan and Howard Halls at POTTC, Stone at a cost of over £1.5m and is now part of the college under its present Principal Mr K E Stotesbury. It replaces the well known MT school at Yeading in Middlesex. With a teaching staff of around 40 it will have a capacity for 150 students and a throughput of upwards of 2000 students a year. Students will use Howard Hall's dining, recreation and bedroom facilities. As well as providing extensive new buildings, we have retained and adapted one of the site's substantial war-time buildings for diesel engine training and other purposes. Training on vehicular mechanical aids will be included and a novel feature is a new building with an internal height of 15 metres. This will allow the highest elevating platform to be fully extended indoors without risk of accident; so bad weather will not cause a problem.

The site of the new MT school was used during the second world war as a loading place for munitions on to railway wagons when the whole area around was a giant ordnance complex. The 75 acres (30 hectares) of the original TTC, which we bought after the war, was part of the associated hostel area in the design of which Mr Billy Butlin is thought to have had a hand. The single storey hutments built originally as residential quarters have served us well for training but we are steadily replacing them. 864 student bedrooms, 150 staff bedrooms and a first training block have been built over the last few years and a second training block costing over £1.5m has just been started.

TTC Stone with a total staff of 450 (including 200 teaching staff) is so well known and all-embracing that a list of its accomplishments would be tiresome. Suffice it to say that it deals with the bulk of TO training courses and quite a few courses for engineering supervisors in its current total of 200. It provides postal mechanisation and drawing office training and fairly recently has also undertaken the task of writing a much needed reference book on modern exchange switching systems. Training courses cannot be run and kept up to date, of course, without continuous research into equipment and practices, and the staff at TTC have a reputation for this. Long before new equipment is installed in the field TTC will have been busy in advance of published information finding out all about it and acquiring circuit diagrams, test gear and in most cases a model of the equipment itself. A good example is new exchange equipment; we have to get in early and order a training model for Stone and with the co-operation of Operational Planning Department (OPD) we reckon to get the second production model equipment. The second TXE4A (the integrated circuit version of TXE4) will be installed at Stone in 1979; the first operational exchange will be at Belgrave in the MTR.

It is invidious to pick out a few examples of new equipment when the TTC trains staff to maintain so many types and vintages but there are courses coming along for digital transmission, new PABXs, and HV power and the first System X course (for THQ staff initially) is already being prepared. We are keeping an eye on fibre optics and Prestel. It is difficult to provide training courses at short notice because lecturers and instructors themselves must first be trained but we do sometimes have to 'pull out all the stops' as in the case of the IBM 3750 PABX when full maintenance was taken over from IBM. In that case one of the old hutments was made ready (with adaptation for under-floor cabling) and a model PABX installed in record time – at a cost of £150,000.

Training in regions and areas

But if I dwell too long on Stone it would give the wrong impression. If you look at the last PO Report and Accounts (the figures are a bit awesome!) you will see that training cost us £47m in 1976/1977 – nearly as much as the investment in research and development. Where did all this money go? Well, a large part (about two thirds) went on engineering training as might be expected – the pay of staff under training and their travelling and subsistence expenses all get counted. Some three quarters of all engineering training, including the training of apprentices, is done by regions. All regions, except SETR, have a regional engineering training centre (RETC). SETR is the exception because it was originally part of the Home Counties Region which had an RETC at Bletchley Park, now in ETR. RETCs run a much smaller range of courses than TTC but they provide the basic knowledge and skills on which TTC courses can build. Together they provide nearly 100,000 student weeks of training every year. Although most courses are run by most RETCs, national uniformity is achieved by control at THQ. Nevertheless, a good deal of the course design is done by the project staff of RETCs whose experience and direct contact with students can be especially valuable.

Apart from LTR, there are no major area training centres. The predominant role of areas is on-the-job training. Training centres can impart knowledge and teach skills but there is no substitute for practical experience. This is especially true for apprentices who are given full opportunity to learn by doing real work under the eye of an expert and the guidance of the Area Training Officer. At THQ training is a matter for Telecomms Personnel Department whose responsibility includes consultation with the Unions – in the case of engineering training, POEU and

SPOE. There is a standing Joint Committee which meets quarterly and a TT(A) panel which also meets quarterly. This is where training news is discussed, trials are kept under review and any differences of opinion ironed out. Between meetings the way is always open to follow up current issues.

Self-instruction

The need for training does not change – new equipment and practices don't stop coming, nor will staff remain in the same jobs indefinitely. But does our attitude towards training change? There has been a gradual recognition that in certain aspects self-instruction can have some advantages over the current training techniques which are themselves as different from "chalk and talk" as chalk is to cheese. This means that, if a student can learn at his own pace and can test himself as he goes along, in the right circumstances he can learn more effectively. A slow change is creeping into our training and this is what is happening in other countries too, as we know from conferences of the International Telecomms Union (ITU) attended by TPD staff. What remains to be seen is whether this change will be accelerated by the application of computers to training. There is wide interest in this – in 1975 the Government allocated £2M to the pioneering of computer assisted training. We obtained a modest grant towards a trial held at the SWTR RETC in which we used computer teaching on the customers' apparatus maintenance course. Students were presented with instructions and exercises by a VDU (a visual display unit such as is now being used in area offices for accessing the computer at the heart of the new pay and billing systems). The computer also handed out graded practical work and when necessary told the student to seek the help of the tutor in charge of the class.

The trial of computer based training (CBT) has given us useful experience about the facilities it offers but the wide application of this method of training raises all kinds of questions, particularly about its cost-effectiveness. Nevertheless, in co-operation with the computer experts in Telecomms Management Services Department we are studying possible further trial applications. CBT will not come in a great rush because it takes considerable effort not only to programme the computer so that it stores all the course material, but also to prepare the training material so that it can provide a route through the learning process tailored to each student's ability and needs.

Another change taking place is, of course, the rapid infiltration of electronics throughout our equipment. Technology is changing faster than ever and micro-electronics and digital techniques are beginning to appear. Computer-like processes will bring 'software' – the means of giving a computer its instructions. More and more staff will have to be trained on the most modern equipment and will need to be given sufficient tuition in the new technologies to perform their jobs effectively. One development of interest here is a self-instruction electronics kit designed by the staff of MTR RETC which allows a student to make sure he will not be frightened by electronics before going on a training course. As soon as the kit has been proved satisfactory in use, we are planning to make it generally available.

The Technician Education Council

Technical job training must be based on the right technical education which is itself undergoing a revolution. With the switch to new courses at technical colleges, City and Guilds and National Certificates are being progressively phased out in favour of the new courses controlled by the Technician Education Council (TEC) and the Scottish Technical Education Council (SCOTEC). These Councils were set up by the Government in 1973 following recommendations by the Hazelgrave Committee in 1969. Although the change-over will not be without its problems, we hope the longer term outcome will be an education system better geared to technicians' needs. The opportunity is now being taken, for example, to review job requirements and update the content of the new courses. Booklets for students were published last June (available from Training Officers). The TEC is the subject of an article in the January 1978 *IPOEE Journal*.

Safety

Last, but by no means least, something needs to be said about safety. The Government took the lead in stimulating greater awareness by passing the 1976 Health and Safety at Work Act (see *TI M4 E0002*). Now it is up to all concerned to make safety their personal business.

The PO is second to none in specifying safe working practices and in designing plant and equipment with safety in mind. On training courses we see that correct practices are taught and the avoidance of hazards stressed. Supervisors can do much to cultivate the right attitude to safety by drawing attention to the risk of hazards if the practices taught at training centres are not conscientiously followed. But a supervisor might not have had the benefit of the latest course so, in the spirit of the Act, we are progressively introducing special skill courses for supervisors to bring them up-to-date.

Good maintenance is fine : good maintenance without risk of accident is better. Have a safe 1978 !

TP7 (01-432 3970)

CEL 4000—supervisory and fault locating methods on 12MHz coaxial line systems

by **Brian Crogman,** Sv7.2.1

The prime advantage of our CEL 4000 systems is that they each provide 2700 circuits while using the same small bore coaxial cable network as the earlier 4MHz 960 circuit CEL 1006 systems. This article outlines how interrogation pulses and direct current measurement are used for monitoring and fault locating on CEL 4000.

For supervisory and control functions small bore coaxial cables – 1.2/4.4 mm – were originally provided with special interstice pairs. To keep the size and cost down only two such pairs were provided for each coaxial pair. In the case of the 4MHz systems this led to complex combined speaker and supervisory schemes, but for CEL 4000 the supervisory system utilises the coaxial cable's power feeding and transmission path – leaving the interstice pairs to be used for speaker and control purposes only.

There are two distinct parts to the CEL 4000 supervisory system :

☐ overall HF supervision and primary fault locating from terminals ;

☐ DC fault locating from power feeding stations for power path failures.

HF supervision

The following features are incorporated :

- supervision of every repeater in the system ;
- continuous self-monitoring resulting in an alarm when a fault is detected ;
- standardisation of repeaters leading to ease of maintenance ;
- no individual route calibration is necessary for fault locating ;
- no electro-mechanical relays in repeaters ;
- improved monitoring of intermediate stations and remote terminals in comparison to earlier supervisory systems ;
- operation from either terminal.

Basically, the HF supervisory system works in the following way. At the monitoring terminal a DC interrogation pulse – 100 μsec duration, 4±0.5V amplitude – is injected into the coaxial cable's power feeding path in the opposite direction to that of the HF transmission. When it reaches a repater – the dependent repeater shown in fig 1, for example – provided the repeater is drawing power the DC pulse is extracted at the power separating filter (PSF), regenerated and

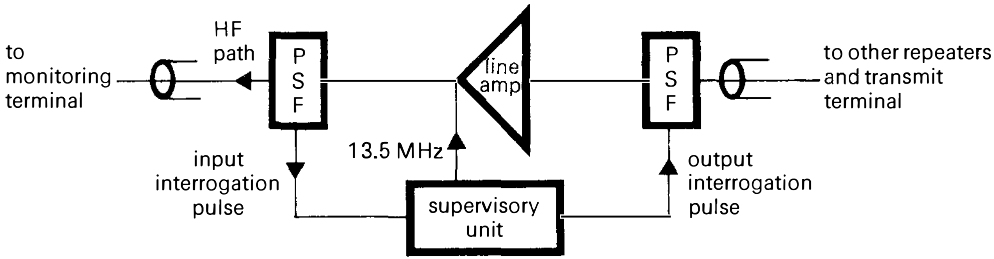


Fig 1: Supervisory at a CEL 4000 dependent repeater

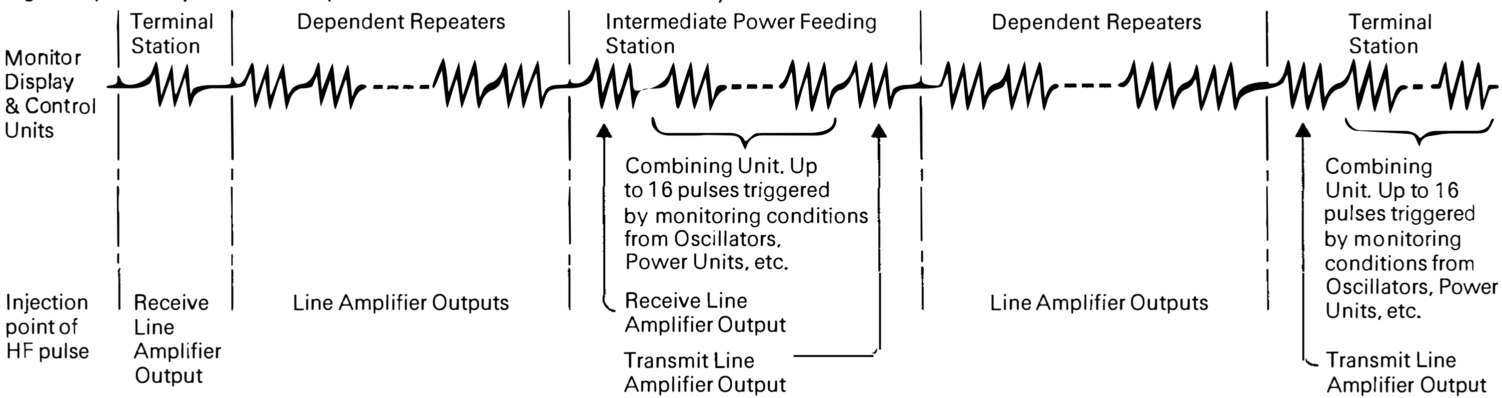
forwarded on to the next repeater. At the same time a 13.5 MHz pulse is injected at the output of the line amplifier and returned to the monitoring terminal in the normal direction of transmission.

At intermediate power feeding stations and the remote terminal the supervisory arrangements provide for several extra pulses of 13.5 MHz to be injected into the HF path – indicating that those station's oscillators and power feeding units are also working normally. The 13.5 MHz pulses are of 100 μsec duration and are spaced 266 μsec apart. Thus, for each interrogation cycle a supervisory pulse train (fig 2) is received by the monitoring terminal – each pulse indicating the condition of a particular unit along the route. The pulses are automatically counted and checked for correct level (±3dB). An absent or out of limits pulse gives rise to an alarm whereupon the operation of a key results in a numerical display on the terminal s monitoring unit corresponding to the position of the last good pulse in the train. Any particular pulse can be selected for display and measurement. This helps, for example, in locating an amplifier with incorrect gain somewhere along the route even if subsequent amplifiers have restored the transmission signal to its correct level. For non-urgent conditions up to six out-of-limit pulses can be overriden provided no more than three of these are consecutive in the train. The interrogation cycle is continuously repeated at either three or six times each second, depending on the route length.

DC fault locating

A disconnection or short circuit in the coaxial cable's power feeding path is located by

Fig 2: Supervisory Pulse Train (*one direction of transmission shown*)



testing from the appropriate power feeding station.

Fig 3 shows how a disconnection is found. 0.5 mA is driven through each 'fault locate' resistor up to the disconnection. In this example 1.5 mA would be measured – indicating that the fault is past repeater three.

Fig 4 shows how a short circuit is found – either an inner to outer or inner to earth fault. The driving voltage developed by the constant current source of the power feed unit is the sum of the voltages dropped across each repeater up to the fault. This is approximately 35V for each repeater and in the example shown would be about 70V.

Compatibility

The terminals are identical, so while each one normally supervises only its incoming direction of transmission, it is possible for either to take overall control of the supervisory system by looping its distant end.

The supervisory units of intermediate power feeding stations and terminal stations are interchangeable – even those by different manufacturers. So we are able to centralise maintenance repair within each region, using a single tester (Tester 184A) and one set of spares. Supervisory units of dependent repeaters come in two types but each of these is compatible between manufacturers. So we can economise on spares here also.

A general description of CEL 4000 equipment is given in *IPOEE Journal* Vol 63, page 234.

Sv7.2.1 (01-432 1369)

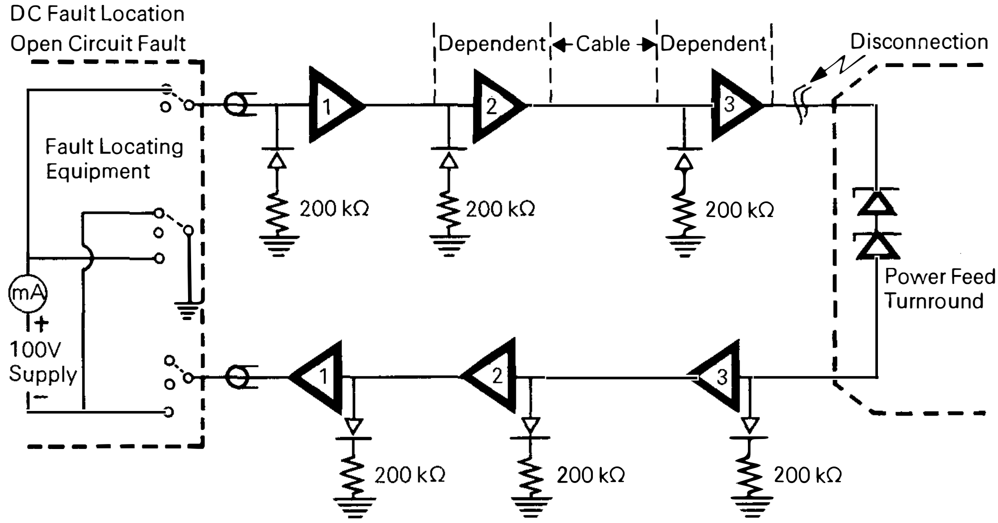


Fig 3

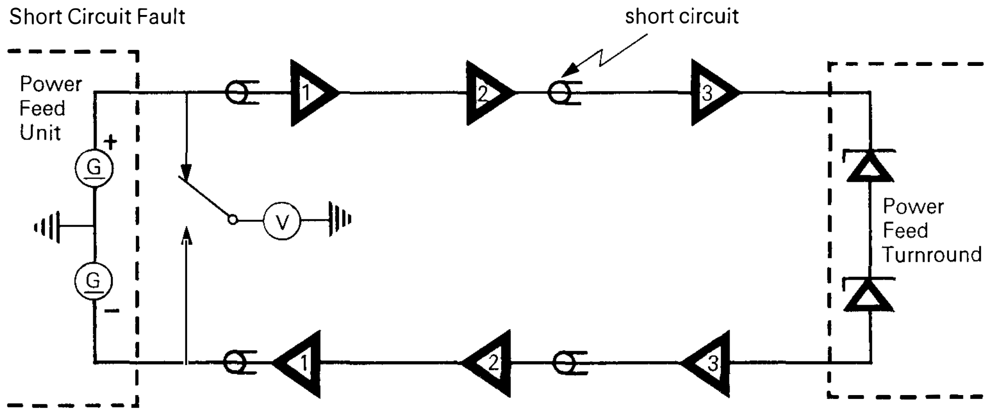


Fig 4

Television network switching for the IBA—A vital but little-known task

by **Doug Newberry,** Sv7.3.3

The PO Network Switching Centres (NSCs) are the terminal points in a network of vision and sound links which we provide for both the BBC and the IBA. These links interconnect the broadcasting authorities' own programme switching centres, studios, monitor centres and transmitters. NSCs are established in the main population areas where our customers' studios and other important premises are located. Fig 1 shows a simplified schematic diagram of the TV links in a typical city.

Under fault conditions NSCs can quickly restore a service by switching to alternative plant. As for scheduled switching, the BBC normally do this themselves. But, for the IBA, the PO NSCs interconnect the network in accordance with a schedule and pattern called-for by the IBA and the independent programme companies. This is referred to as the 'Schedule of Allocation of Network Links'.

Basically our switching equipment provides for interconnecting the incoming and outgoing links so that:

□ any source can be connected to any destination;

□ a destination can only be connected to one source at any given time;

□ transmission suffers minimal distortion.

Here, we briefly describe the ways in which we do this switching.

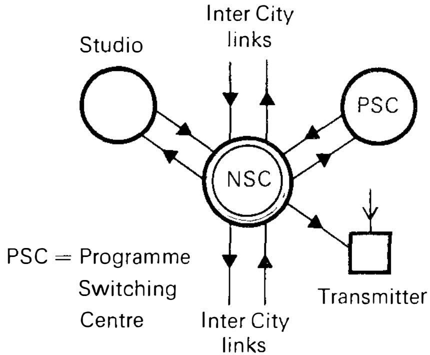
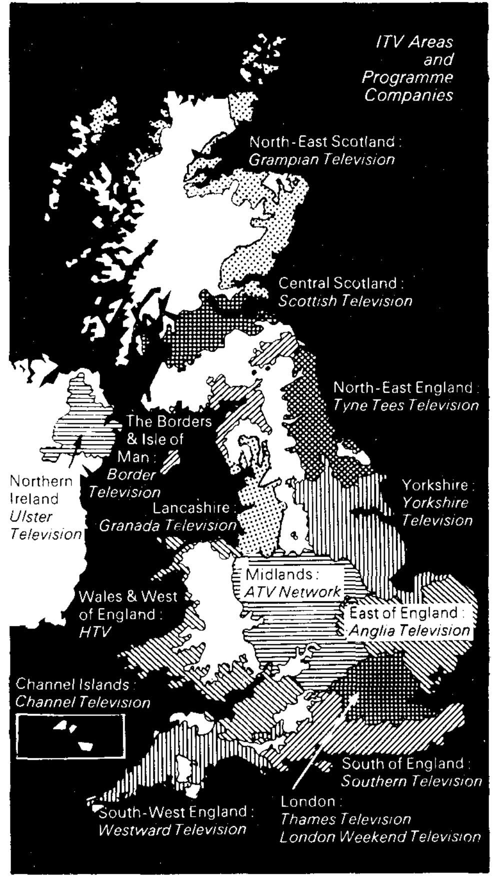


Fig. 1. Simplified Schematic of Television Links in a City.

Manual patching

This is done in all NSCs but is the main switching facility in seven small ones where the number of vision and sound circuits switched is less than five each day. Links are terminated on video and audio distribution racks and interconnections are made either by U-links or patching cords. Up to six outgoing links can be fed from one source by using a video distribution amplifier. Sound sources are distributed by means of a resistive splitter which feeds up to 12 outgoing circuits. The time allowed for a manual patching operation is ten minutes.



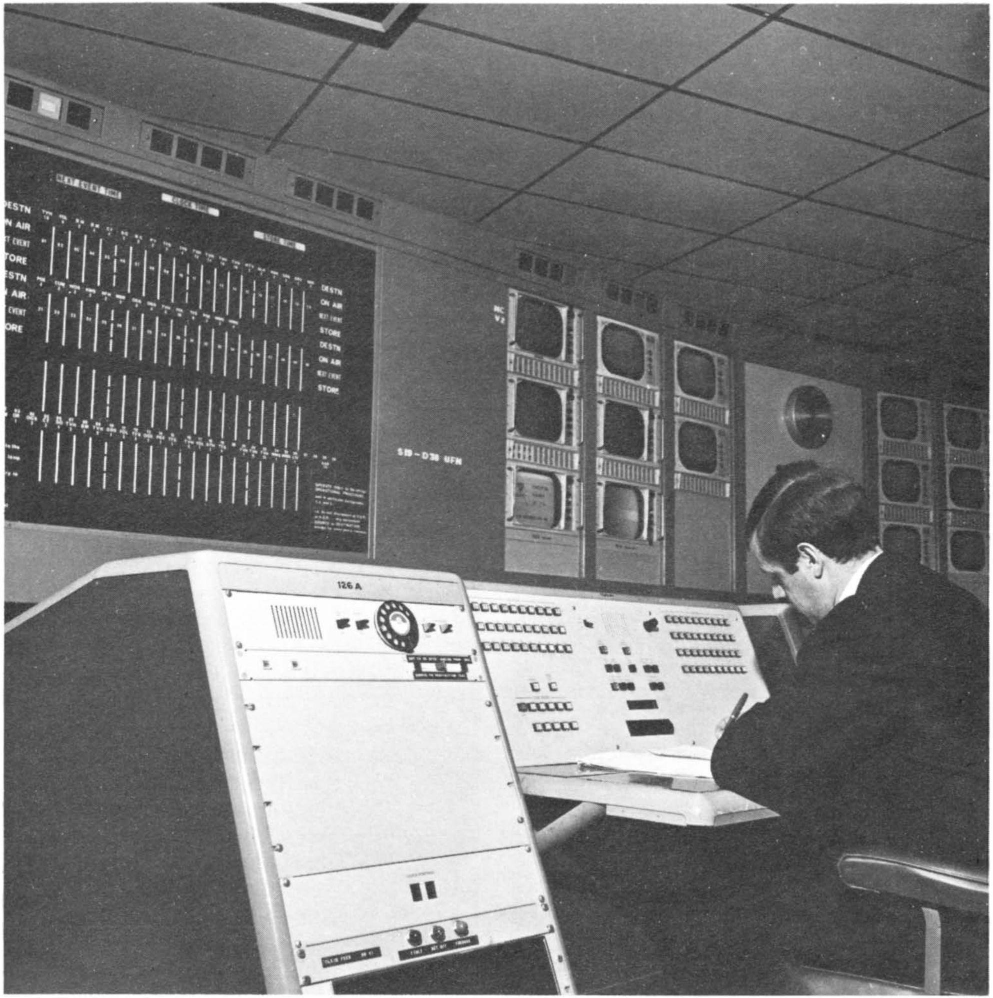
Key switching and distribution amplifiers

These are used at four NSCs where between five and ten switching operations are called for each day – more than at the smallest centres but not frequent or complex enough to justify providing fully automatic equipment. As with manual patching, both incoming and outgoing links are terminated on vision and sound distribution racks. For vision, incoming circuits are then connected by U-links to distribution amplifiers; and for sound, incoming circuits are U-linked to resistive splitters. Switching is effected by manual operation of one or more keys. These select the appropriate outputs from the amplifiers and splitters and connect them to the outgoing circuits on the distribution racks. The time allowed for this type of switching is one minute.

Staff are notified by an alarm normally three minutes before a scheduled switching operation. This is done by an audio-visual clock device – Equipment Time Alarm 1A. When the alarm is heard a key on the clock is operated which removes the alarm and connects TIM (the speaking clock) to a loudspeaker. TIM is the reference time for the switching operation.

Marconi automatic network switching equipment

At London, Birmingham, Manchester and Carlisle NSCs the interconnection of incoming and outgoing vision and sound circuits is normally made automatically. At London the equipment provides for 30 sources and 40 destinations while at the other three provision is made for 15 of each.



The NSC console and display panel at PO Tower, London

The time allowed for this type of switching is ten seconds except for the Friday night changeover in London between the Thames TV and London Weekend companies. On this occasion the feeds to the Croydon transmitter are switched over instantaneously.

The equipment is in four basic parts. Two of them – the control panel and the visual display panel – are in the television control room, while the other two – the clock unit and the switching equipment – are in the television repeater station.

The *control panel* is mounted in a console and has two modes of operation – monitor or operate. In the operate mode the console controls are energised, thus allowing the operator to programme the equipment for source to destination connections and their timing. In this mode, control of switching operations can also be effected manually if necessary. The monitor mode enables monitoring at the console for sound and vision on all sources and destinations. In this mode all other control functions are de-energised to prevent inadvertent misoperation.

The *visual display panel* is mounted in front of the console. It gives an alpha-numeric display of all patterns programmed into the equipment. Each destination has three displays each showing the sources (represented by two-digit numbers) which are and will be connected to that destination in the next two switching operations. Fig 2 shows a typical source/destination

Destination	BM 2	BM 4	NC 2	SO 2
On Air	01	12	12	13
Next Event	09	09	03	05
Store	02	02	02	02

Fig. 2. Display Panel. Each source is represented by a two-digit code.

display. As each switch occurs the information moves up one stage – 'Next Event' to 'On Air', 'Store' to 'Next Event' and the 'Store' display is extinguished ready for the operator to programme a new event.

Three times are also displayed on this panel. The 'Real Time' shows the actual time of day to one second, while the 'Next Event' and 'Store' displays show the required switching times for those two patterns.

The *clock* is in two sections. The first is a PO designed electronic unit which generates a very stable supply of one second and ten second pulses synchronised with the speaking clock, while the second section is a clock and logic unit made by Marconi. This is mainly electro-mechanical. It uses the pulses from the first unit to drive chains of PO Type-4 uniselectors which form the Real Time clock. This clock has two identical parts – Real Time and Real Time Comparison – which must be exactly in step with each other for an automatic switch to occur. Two more chains of uniselectors – Next Event and Store Time – provide the switching time stores. When time coincidence occurs between the Real Time clock and the Next Event store a control signal is sent to the switching equipment and a switching operation takes place.

The *switching equipment* consists of electronic transmission path equipment and electro-mechanical control and storage equipment. The latter uses motor uni-selectors (MUS) because of their high rate of search (200 steps a second). Each destination has three MUSs – 'On Air' 'Next Event' and 'Store'. At the instance of the switching operation, when a change is scheduled, the control condition from the clock causes the destination 'On Air' MUS to hunt for a marking condition fed from the 'Next Event' MUS. When this is completed the 'Next Event' MUS hunts for the marking condition from the 'Store' and so the information moves forward. The 'Store' is then ready to be programmed with the next changes.

The sound transmission path consists of a transistorised input amplifier on each source, capable of feeding up to 20 destinations. The vision transmission path is somewhat different. Each source has an imput distribution amplifier which has four outputs each capable of feeding a relay crossbar matrix. The output from the matrix is fed to the destination amplifier. The matrix is built up with miniature sealed relays mounted in strips, one strip for every source, each strip having one video input and ten outputs. A matrix can be assembled to accommodate a maximum of 40 sources and ten destinations.

The operation of this equipment is a

skilled job. It calls for the ability to translate switching requirements into the minimum number of switching operations. Amendments to the switching schedule – caused by programme changes and so on – are received regularly from the IBA Lines Booking Office. Thirty minutes is normally the minimum notice required but a large number are accepted inside this period depending on the NSC work load at the time. In the three years ending December 1976 a total of 111,097 switches were made of which 0.035 per cent were misoperations due to human error. This reflects a high order of operational efficiency.
Sv7.3.3 (01-432 1429)

A change in battery maintenance

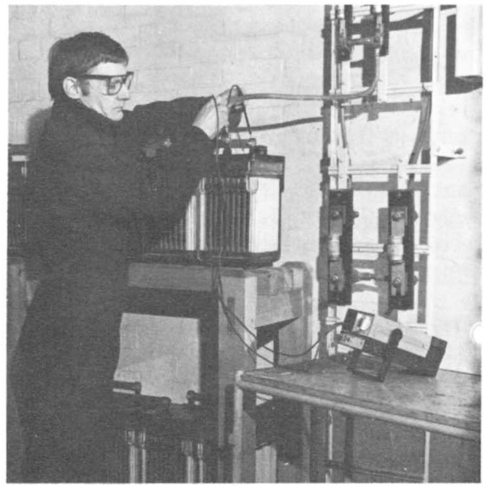
by **Jim O'Connor,** Sv5.4.2

Future issues of TIs giving routine maintenance tasks for 'float trickle charge' power plants will call for the regular measurement of cell voltages instead of specific gravity. What is the reasoning behind this change?

The traditional method of assessing a cell's condition is to measure the specific gravity (sg) of its electrolyte using a hydrometer. For accuracy this measurement depends on the electrolyte having a uniform sg throughout. This, in turn, depends not only on the chemical reaction within the cell during charging being sufficiently vigorous to mix the electrolyte but also the extent to which the cell's plate assembly permits its circulation.

Neither of these conditions are fully satisfied in modern power plants. The design of float trickle charge power systems such as Power Plants 123, 227 and 233 are such that their batteries do not require refreshing or equalising charges. Their cells are at all times maintained within closely controlled limits (2.22 to 2.3 Volts). Normally they accept only a small trickle charge to make good internal losses – re-charging automatically after a discharge caused by loss of mains. This re-charging takes place at the most economical voltage – without the energy wastage and excessive gassing which occurs in earlier float systems where cell voltages up to 2.6 may occur. However, the reduced gassing is hardly sufficient to adequately mix the electrolyte.


The old way...


...and the new way

Furthermore, in the high performance planté cells most commonly used with those plants the closely packed plates and continuous microporous plate separators restrict this already small circulation still further. The result is 'stratification' – the sg of the electrolyte varies according to the depth and can no longer be used as a reliable check of the cell's condition.

But we know that keeping the cell voltages within the above limits means that their good condition is assured. So sg readings aren't necessary on constant potential DC power plants ; they can be replaced by cell terminal voltage readings provided these can be measured accurately enough. In the past, dynamometer or moving iron meters of sufficient accuracy were too fragile for practical use. But now we have a small, robust, multi-range digital voltmeter which is ideal for this purpose. It is called Meter, Multi-range 17A. With it we can read cell voltages to an accuracy of ± 10μV. We can thus compare each set of voltage readings with previous ones so as not only to check the general state of charge but also to detect cell faults. (Experience shows that, for example, a plate disconnected from its group bar or a broken pillar cause an increase in cell voltage while a short circuit between plates causes a decrease.) An added bonus is that this voltage reading technique is more convenient and less time consuming than taking sg readings.

In the older float plants (Power Plants 210 and 225) where a gradual reduction in battery capacity has to be replaced by routine charging, normal variations in cell voltages tend to make the new technique less effective so, for the time being, we'll continue to take sg readings on these plants generally. We are, however, recommending the use of voltage readings in specific cases of Power Plants 210 or 225 where stratification is a particular problem. (Some plants powering crossbar exchanges are notable in this respect.) Even here though, sg readings will still be taken after refreshing and equalising charges.
Sv5.4.2 (01-432 9041)

System X

Here, Telecommunications Systems Strategy Department (TSSD) answer some basic questions about the background and nature of the system which will bring us into the digital switching era in a total systems concept.

Why are we seeking a new generation of telephone systems?

Existing electro-mechanical systems cannot be economically adapted to provide the facilities and the quality of service we must offer to customers in the future. On the other hand, up to date technology is not only capable of meeting the future needs of customers but also is becoming more economic to make and install than earlier equipment. New systems are also able to provide better facilities for those who operate them, particularly in the fields of network management, servicing and accounting. Furthermore, the economic advantages of such systems become much greater when their development and modes of operation are determined as an overall plan – a total systems concept. Advantages we are seeking with this concept are:

- the capability of evolving to meet the future needs of telephony customers in terms of facilities and reliability;
- scope for gradually creating a network in which other services are run jointly with telephony – an integrated services network;
- substantial reductions in overall cost;
- large reductions in equipment size;
- much shorter procurement and installation times.

What is System X?

Basically it is a plan for a family of new switching and associated systems using micro-electronics, integrated digital switching and transmission, stored programme control and common channel signalling. These systems are built up from subsytems – modular 'building bricks' –

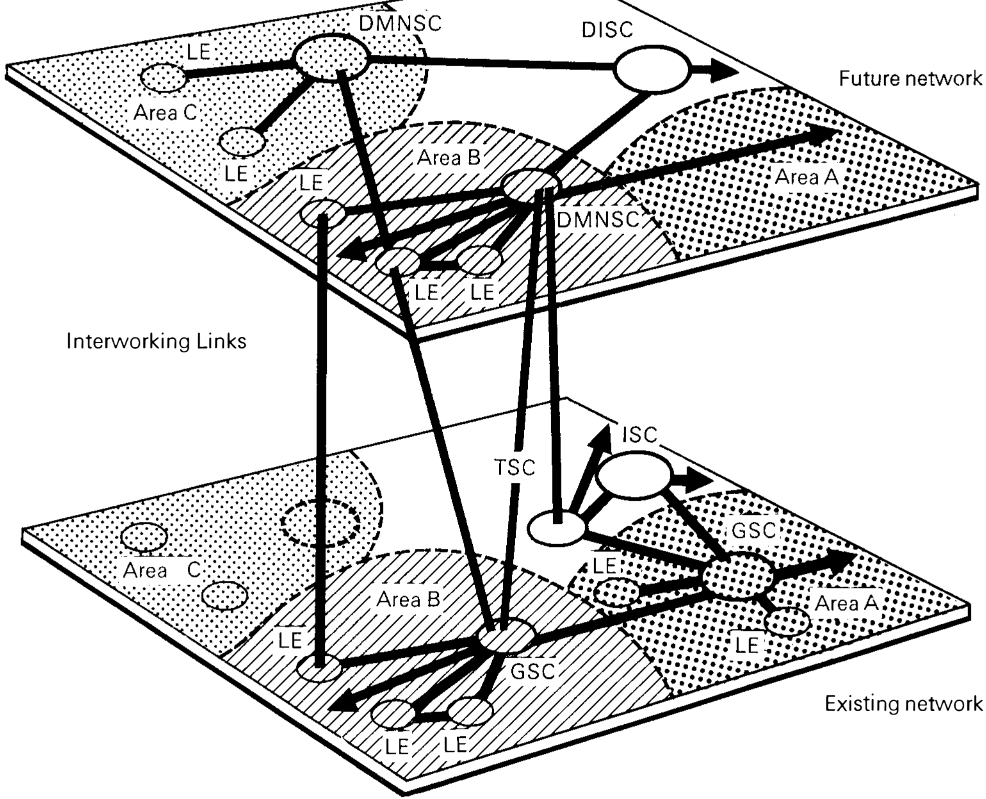
which are being designed to common standards. Many of them will be multi-purpose so enabling them to be used in various combinations and configurations to meet diverse planning and service requirements.

One way in which System X could be introduced is as an overlay to the existing network, having the minimum number and variety of interfaces with it and therefore remaining virtually free of constraints due to interworking. The diagram shows how this might be done. It highlights three phases in the gradual transformation of an existing (mainly analogue) network into the new (mainly digital) network of the 1980s, and shows how the evolution of the network can proceed at different rates, governed typically by local circumstances or by national policy.

In the first phase, illustrated by Area A, the existing local exchanges (LE) and their group switching centre (GSC) continue to serve the area and to use the existing trunk transit network. The area remains almost unaffected by the introduction of System X elsewhere in the national network, although it may acquire interworking links to some System X exchanges.

In the second phase, illustrated by Area B, the existing local exchanges and their group switching centre continue to serve many customers in the area, but some or all of these exchanges are overlaid by System X exchanges which serve the other customers. The new exchanges may be introduced for a variety of reasons, such as to cater for growth or to provide a nucleus of new equipment pending the replacement of old equipment

Overlay Concept



Area A – Existing Exchanges not yet overlaid or replaced
Area B – Existing Exchanges overlaid by System X
Area C – Former Exchanges completely replaced by System X

Key:

LE	=	Local Exchange
GSC	=	Group Switching Centre (Trunk Exchange)
DMNSC	=	Digital Main Network Switching Centre (Trunk Exchange)
TSC	=	Transit Switching Centre (in 4-wire Trunk Transit Network)
ISC	=	International Switching Centre
DISC	=	Digital International Switching Centre

which has come to the end of its economic life. The balance between old and new exchanges, and the locations and number of interworking links depend on prevailing local conditions.

In the last phase, illustrated by Area C, the former exchanges have been completely replaced by System X local exchanges and a digital main network switching centre (DMNSC) which now serve the whole area.

Existing international exchanges will continue to serve the national network for many years, but will be supplemented by System X international exchanges.

Naturally, in practice, the three phases of network transformation shown in this diagram will tend to be less distinct and will merge from one to the next in a gradual process spread out over many years.

How is System X being developed?
First, by creating an overall strategy through intensive collaboration between the PO and its main manufacturers – GEC, PTL and STC. Within this strategy individual manufacturers are undertaking development projects through contracts let and funded by the PO. These contracts provide for the transfer of design and related information between all four parties to enable each to carry out its share of the programme effectively. We are able to build on experience gained from systems such as TXE2, TXE4 and digital transmission systems as well as development recently undertaken by manufacturers privately. Thus, new techniques and processes will be researched, tested and made operational.

The development of System X is a very major project: Hundreds of professional staff are now involved in the PO and Industry, and will be involved for several years. Scores of racks of model and test equipment will be required to validate the designs through to production. All told, the development costs are likely to exceed £100m. This cost is high, but it should be seen in the context of potential procurement programmes of some £1000ms in the UK alone, and the prospect of a substantial export market.

When will System X be available?
The overall programme provides for the development of System X for a comprehensive range of applications, but highest priority is being given to the development of digital switching systems for junction, tandem and trunk purposes, closely followed by a family of local exchanges required to meet the diverse situations that arise. It is planned to built up production in the early 1980s for an expanding range of applications that exploit much of the basic designs proved in the early applications. This programme includes System X applications for international, manual board, and data services, and for a range of network management, servicing and accounting centres that will be appropriate for the 1980s and beyond.

We hope to publish further information on System X in due course, particularly concerning the maintenance aspects. (*Editor*).

Q Points the way!

by **Ron Quinney,** Sv5.4.2

Ever had trouble finding the TI you wanted? If so, the new TI indexes are designed to help you.

Over the past few months new indexes have been prepared for all TIs. They are themselves published as TIs in their own numbering series – Q. This is a convenient letter because, apart from being universally accepted as a request for information or enquiry, its place in the alphabet means that each index will be located at the end of each TI file – which is where you would expect it.

For maintenance staff, indexes are initially being distributed only to files held by AEEs and inspectors (Type 3 files), executive engineers (Type 4 files) and to HQs (Type 5 files). Eventually, we hope to provide them for selected Type 2 files but this will take some time.

The first issues of Q TIs have been composed from lists held at the Edinburgh TI Distribution Centre, and they'll be kept up to date by regular amendments and reissues. In principle, a TI can have up to three entries in an index – based on key words in its title. For example, TI E13 A2010 can be found under:

MAC
Measurement and Analysis Centres and
Telephone network performance measurement using MAC.

The index number
Each index is numbered according to the TI sub-division to which it refers. For example Q3 *E*000*7* refers to Telegraph Maintenance (sub-division E7). The table shows this relationship for all E (Maintenance) sub-divisions. An important feature is that each index is a complete alphabetical list of those TIs which should be in any file whose composition includes the *whole* of a sub-division – including relevant TIs from other divisions (A, C, D and so on) normally distributed to it. A 'Signpost' TI, *Q2E0000*, is there to point you in the right direction if you have only a vague idea where to find a specific maintenance instruction.

Updating
Naturally, any reprinting and redistribution of amendments takes time. But the aim is for updating indexes at least every six months. In between times, fileholders should be guided by the monthly THQ circular which gives recent changes in new, amended and cancelled TIs.
Sv5.4.2 (01-432 1380)
Editor's note: Mr. Quinney is Engineering Division TI Adviser.

			Index TI Number	TITLE
			Q1 A0000	LIST OF ALL TI DIVISIONS
Division	E	Maintenance	Q2 E0000	'Signpost' entries for E Divn. TIs
		SUBJECT		
Sub-Divisions	E1	General	Q3 E0001	Index for E1 Maintenance – General
"	E2	Overhead	Q3 E0002	E2 – Overhead
"	E3	Underground	Q3 E0003	E3 – Underground
"	E4	Submarine	Q3 E0004	E4 – Submarine
"	E5	Stations (Teles)	Q3 E0005	E5 – Stations
"	E6	Exchanges	Q3 E0006	E6 – Exchanges
"	E7	Telegraphs	Q3 E0007	E7 – Telegraphs
"	E8	Data	Q3 E0008	E8 – Data
"	E9	Line Systems	Q3 E0009	E9 – Line Systems
"	E10	Television	Q3 E0010	E10 – Television
"	E11	Radio	Q3 E0011	E11 – Radio
"	E12	Power	Q3 E0012	E12 – Power
"	E13	Controls	Q3 E0013	E13 – Controls
"	E14	Radio Interference	Q3 E0014	E14 – Radio In'ference
"	E15	Office Machines	Q3 E0015	E15 – Office Machines

Teaching aids to fault locating on submarine cables

by **Derek Foxwell,** NP5.2.3.4

The locating of faults on submarine cables has long been considered a 'black art', in spite of recent advances made in AC testing techniques. As a result, a training course was set up at the POTTC, Stone, to teach terminal repeater station staff how to locate faults on their systems.

The main problem in arranging this course, was to demonstrate, in the classroom, effects obtained during submarine cable testing. This meant that the submarine system had to be simulated so that the response of the simulator to the testing signals was similar to that of the system itself.

Testing methods

There are three main methods of fault location in use on submarine systems. The oldest of these is 'DC measurement', where the DC resistance (in the case of an earthing fault) or the DC capacitance (in the case of a sealed-end fault) is measured to the fault position. Having previously established the resistance and capacitance of the system repeaters, equalisers and cable (per nautical mile), the distance to the fault can be calculated. With earthing faults, an end resistance may exist due to an electrolysis effect. (Dissimilar metals – copper centre conductor and steel armour wires – immersed in an electrolyte, the sea.) Special DC tests are then performed which tend to eliminate the effect of this end resistance, leaving only the resistance to the fault position.

Recently, AC testing techniques needing less operator skill have been evolved which give greater accuracy in fault locating. This is mainly because the varying DC currents present on the cable are filtered by the AC test equipment. The AC techniques used are 'pulse echo' and 'impedance/frequency' testing.

Pulse echo works on the radar principle where low frequency (2 to 16 kHz) sine wave pulses are transmitted to line, part of the pulse energy being reflected by any impedance irregularities (such as faults or repeaters). These reflections are displayed on a cathode ray tube.

When measuring impedance against frequency the input characteristic of the submarine system in the frequency range up to, say, 12 kHz is measured when the length of the cable is sufficient for the characteristic impedance (Zo) of the system to be reached, or otherwise the far end is terminated in Zo. These measurements are repeated when a fault occurs on the cable and a difference curve plotted from the two sets of readings, which allows a mathematical solution to the fault distance providing the AC parameters of the system are known.

Simulating DC tests

Simulating a submarine system to DC testing current is relatively simple. Fig 1 shows a hypothetical submarine cable system containing two cable sections each 6.5 nautical miles (M) in length, and one repeater. In this example, the DC resistance

Fig 1

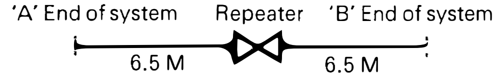


Fig 2a

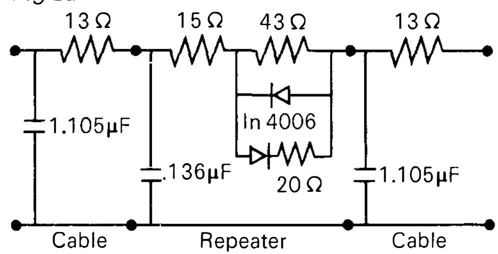
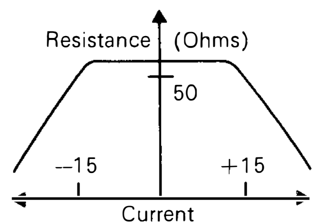


Fig 2b



per nautical mile of the cable is considered as 2Ω and the capacitance per nautical mile as 0.17μF. The DC path through the repeater includes two 'backed-off' diodes which protect the repeater against surge voltages. This modifies the 'DC resistance versus repeater testing current' characteristic at low current values. Fig 2a shows the circuit of the system illustrated in Fig 1, with a typical resistance against current response plotted in Fig 2b. The repeater chosen for this example is the STC 14 MHz type.

These repeater sections (that is, a cable section plus repeater) are connected in tandem to obtain the required system length to the fault. The final cable section is always a special section which has been divided to allow sub-section lengths of one half, one third and one sixth to be selected as the distance to the fault from the preceding repeater.

To simulate the fault condition (that is a secondary cell effect at the broken end), a short section of submarine coaxial cable is connected from the output terminals of the DC simulator. The other end of the cable is immersed in a galvanised iron container filled with sea water (or salt water) to provide the electrolysis effect.

Simulating AC tests

Simulating the submarine cable system to the AC test signals proved a greater problem than for DC. However, TD6.4.1 developed a system where the analogue test signal is converted to a digital signal, enabling the cable and repeater delay to be simulated using a shift register. Fig 3 shows the block schematic of the AC simulator for a system of four repeaters and five cable sections.

The test signal (a single sine wave pulse of either 16, 8, 4 or 2 kHz) which passes into

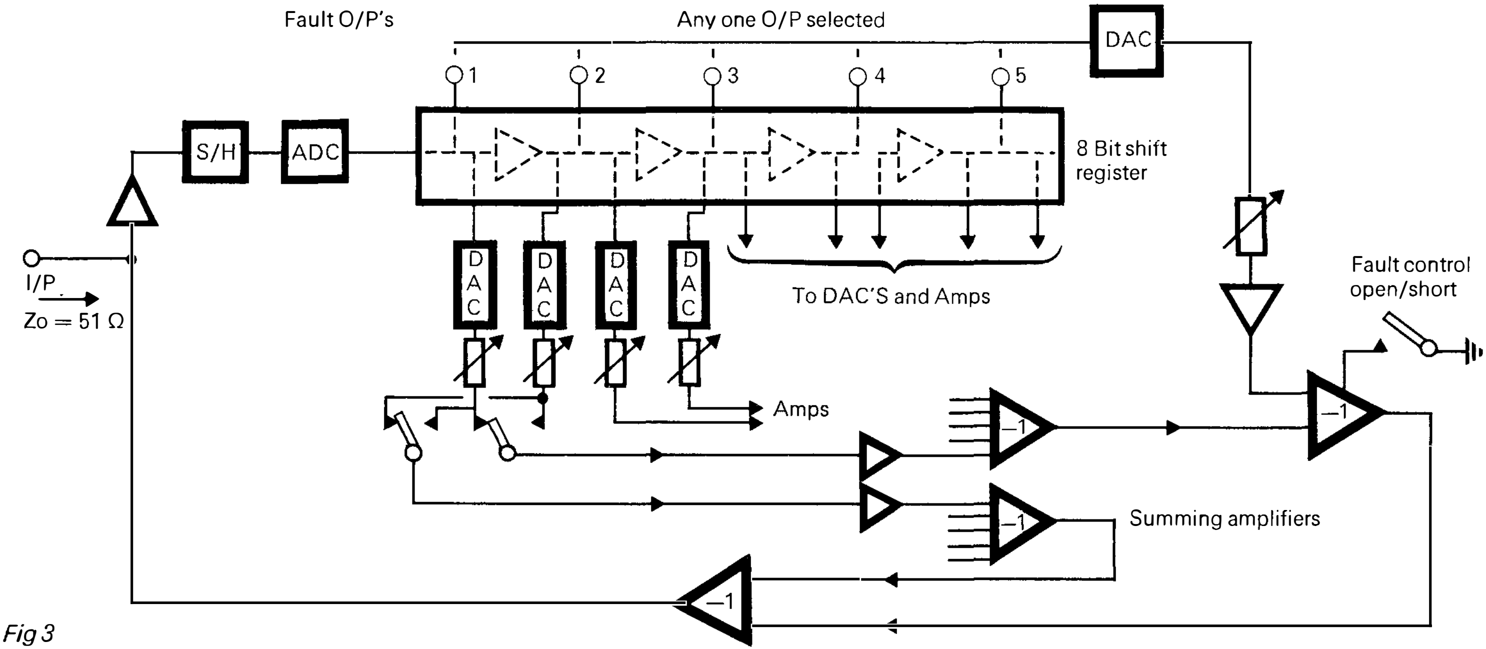
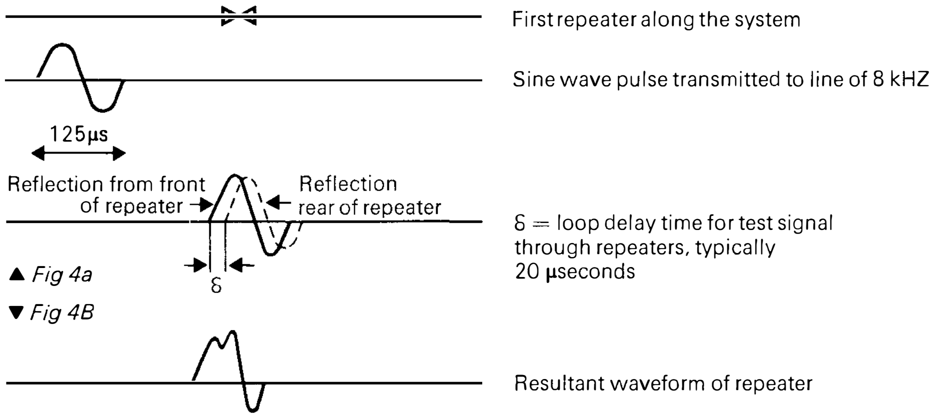


Fig 3



▲ *Fig 4a*
▼ *Fig 4B*

the simulator is processed by a 'sample and hold unit' and an analogue to digital converter. The 8 bit words generated at the sampling rate of 200 kHz are then shifted along an 8 bit wide shift register, each step along the shift register corresponding to a delay of 5 µsecs. The 8 bit words are selected at the outputs of the shift register at points having a delay corresponding to the input and output at the repeaters to allow the typical complex waveform of the repeaters to be simulated. Fig 4 shows the origin of this complex waveform, and the resultant waveform.

Each output drives into a digital to analogue converter (DAC), with the outputs of the DACs' passing through buffer and combining amplifiers into one of two amplifiers. (The amplitude of the reflections can be adjusted by using a potentiometer preceding the DACs.) The choice of the amplifier determines the phase of the reflection, which may be changed by 180° to simulate a repeater input or output, that is, low or high impedance.

A fault condition is represented by 'picking-off' any 8 bit word at one of several preselected points along the shift register and passing it through a DAC into one of the amplifiers. The amplitude of the fault can be adjusted by using a potentiometer preceding the DAC. An open or short circuit fault reflection is selected by means of a switch.

The simulators described are currently being used at POTTC Stone on the submarine cable fault location course (658). Further units will be built to allow certain 'submarine terminal repeater stations' to practice on these models of their systems, to obtain fault location expertise.

Several foreign administrations are interested in the simulators for training their own staff.
NP5.2.3.4 (01-432 1086)

SPC for telex switching

by **Ray Bentall,** Sv6.4.2

If present plans get the go ahead Brighton's Strowger telex exchange will be the first to be replaced by one using stored program control (SPC). It should come into service in 1980 and may be followed by replacement of some of the 50 other Strowger telex exchanges in the inland network.

Some of the advantages of the new exchanges would be ; :

- Better quality of service to customers ;
- Improved customer facilities ;
- A reduction in routine maintenance ;
- More detailed management statistics ;
- More detailed customer billing, if required.

And some of the improved customer facilities which could be offered are :

The date and time sent by the exchange at the beginning of each call ;

Calls set up simultaneously (broadcast) to several customers ;

Number selection by using the teleprinter keyboard rather than a dial ;

Calls set up by keying only two digits for commonly called suctomers (short code selection) ;

Incoming calls automatically redirected to another customer on the same exchange ;

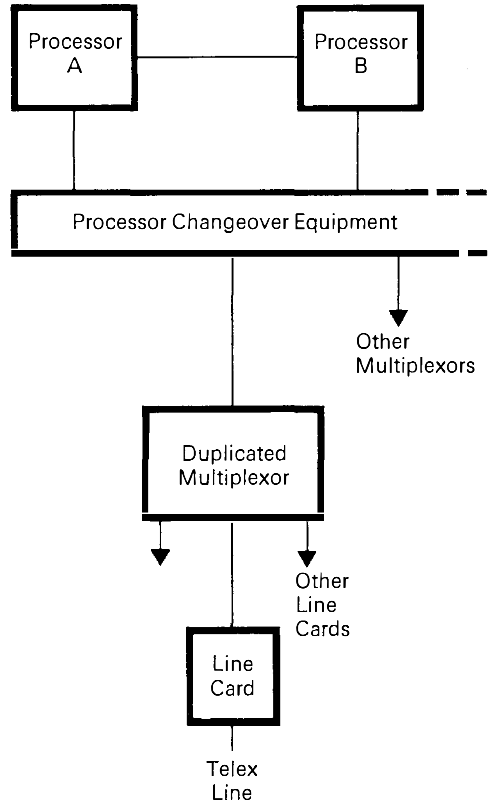
Calls to a customer's old number inter-cepted and a brief message sent to the

caller advising them of the new number. (This may be combined with call redirection) ;
If one customer finds another continually engaged, the exchange stores the message, delivers it later and then advises the calling customer ;
Connection to terminals working at higher transmission rates and different codes, by means of code and speed conversion ;
Private networks set up using normal exchange equipment and trunk routes.

Other features likely to be included in the new exchanges would be :
Telegraph signals regenerated and transmitted at zero distortion ;
Calls charged by recording details on magnetic tape which would then be processed for billing ;
Distorted test messages generated by the exchange itself and an automatic overnight test of each customer's line.
Major items of exchange equipment duplicated for security, with automatic changeover to a standby on failure of the working equipment ;
Two attempts to set up a call and, if necessary, a further two attempts *via* another tandem exchange if the primary route is congested.
At present a number of different systems are being evaluated but they all have the basic features shown in the block diagram.

The line card converts telegraph signals to logic level and the multiplexor scans the output of each card in turn and detects each telegraph character. The characters are transferred to the main processor with the identity of the line card on which the character was received. The main processor first analyses the selecting information received from the customer – either dial pulses or keyboard characters, then selects in its memory an appropriate line card (for either a trunk or customer's line). When the call has been set up, the main processor analyses the address of each character transferred and sends it to the appropriate multiplexor together with the address of the line card which must transmit the character. The multiplexor sends the character to the line card which transmits it to line.

The successful operation of the SPC telex exchange at Brighton will, we hope, be followed by the gradual introduction of others. If so, they will incorporate a redesigned test desk. By then we may also be using a new transmission system – replacing 80 Volt working.
Sv6.4.2 (01-432 1320)



Simplified diagram of typical SPC Telex Exchange

PO Engineering safety guide–RG41

by **Alastair Campbell** OP11.1.1

Revision of the Safety Guide will be delayed for some time. It may even be necessary to resort to a limited re-print of the present edition. Engineering officers should already hold a personal copy of the safety guide and should have received a copy of an EI-TI conversion list for specific use with it. In the present circumstances, any officer who has not received a copy of this list should ask his area for one right away.

For general information, the conversions are reproduced here.

RG 41 EI – TI Cross reference.
Where an EI is referred to in the text the appropriate TI can be found from the following table.

General – General

S 1020	M4 E1020
S 2020	M4 E2020
S 2050	M4 E2050
S 3100	M4 E3100
S 3200	M4 E3200
S 3311	M4 E3311
S 3610	M4 E3610
Z 3004	A2 M0051, J7A0020, E1 H0900

Lines – Overhead

C 3651	E2 B1051
C 5101	*E2 B0015, A2 N1351
E 3134	E2 C0112
E 3631 Never Published	A2 N0201
A 3090	A2 D0090
A 3091	A2 D0091
C 1101	A2 N1051
J 1001	M4 E0600
J 1005	A2 N0291
J 1101	*E2 F1101, A2 E5001
J 1201	A2 E5503

Lines – Underground

C 5901	A2 G0074, *E3 E0101
D 1035	A2 F0301
F 3080	A2 D3105, *E3 A3152
F 5402	E3 H5402
F 5902	E4 B1001
J 1101	E3 H1101
J 1110	E3 H1110
J 1125	E3 H1125
J 1133	E3 H1133
J 1150	A2 D0121
J 1151	A2 D0122, *E3 H2151

Power – Cells

A 0020	A7 E1005, E12 F0002

Protection – General

J 1005	A7 E1001

Staff – General

H 0021	M4 E0021

Staff Establishment

E 0032 to Gen Gen S 4050	M4 E4050

Tools and Transport – General

A 3001	J7 A0013
A 5021	E1 G5010

Tools and Transport – Hand Tools

E 1120	M4 E3100
G 1003	*A2 D0033, E3 J1003
G 1201	E3 J0112
H 1005	M4 E3311
L 1044	A2 E5031
S 1410	A1 F5252, *E1 G7910, *C1 A8105
T 1150	*A2 D0034, E3 J1015

Tools and Transport – Mechanical Aids

B 1009	G3 B2011
B 1010	A2 G0076
C 1035	A2 M0052, J3 D0030
J 1011	J3 E0014
J 1022	J3 E0014
J 1030	A2 N0261

Tools and Transport – Vehicles

D 0023	J5 A0029
D 0024	J5 B0041
D 0031	J5 B0044, J5 A0042
D 0401	J5 B0024
D 0451	J5 B0015
K 0021	J4 F0014, J4 E0013, J4 F0013

*Duplicate TIs which are progressively being eliminated.

OP11.1.1 (01-739 3464 x452)

Microwave radio system maintenance–Transferring the emphasis

by **Richard Balcer,** Sv7.3.1

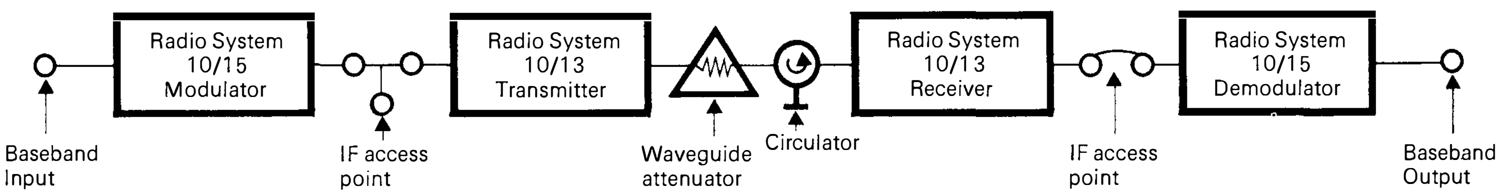
Which is the most effective way of maintaining systems ? Everyone will have their own view on the subject but few would deny that the methods adopted at any particular time must depend on stability of performance, volume of equipment, availability of expertise, and a whole host of other factors, all of which are constantly changing as the system develops.

The number of systems in the PO microwave network has increased rapidly in the past few years and to keep pace with this growth our maintenance philosophy has had to evolve accordingly – improving and rationalising methods and making the most efficient use of resources. In earlier days the bulk of our effort was invested in routine checking of individual units and panels. But now the emphasis has been transferred to the careful routine monitoring of the overall system performance. The cue for remedial action is the excursion from prescribed limits of the system's performance parameters and excessive changes in equipment meter readings.

Since this 'system engineering' approach results in a large shift in emphasis, its promotion and adoption has required some support measures to be taken. Foremost among these is the need for maintenance staff to know the relationships between the overall performance parameters (which indicate a fault) and the radio system parameters (which indicate the cause of the fault). In the past this information was split up and incomplete. Now, however, it has been collated and supplemented and is concisely presented in the form of two wall-charts – one for TV and one for telephony. These have been distributed to all radio stations. In line with the production of these and other wallcharts, a series of 'talk-ins' have been held on all microwave links – putting over the new approach and discussing it with the staff concerned.

But, when it comes to day-to-day work, basic theory alone is insufficient to deal with 'nitty-gritty' matters. So THQ are now producing a series of two-day practical instruction sessions to augment the knowledge gained in formal training. To do this a mobile demonstration unit will be stopping at a number of convenient points on the network to demonstrate parameter relationships in a very practical way. The courses are directed at all staff engaged on microwave systems maintenance including supervising officers.

The demonstration unit consists of a TV outside broadcast van converted into a six-man classroom with seating at one end and radio and test equipment at the other. The radio equipment (shown in the block diagram) comprises a transmitter and receiver connected back-to-back with facilities for the insertion and recovery of signals at various points. It is installed in the rear compartment of the van where cable drums are normally housed. Only the equipment's access points and the wave-



guide connection between transmitter and receiver are brought out to appear on a panel inside. The roof of the inside compartment conveniently serves as a support for the necessary test equipment. The instruction session essentially involves changing the radio responses of the equipment and displaying the effects these have on both TV and telephony test signals. This is done by inserting networks of known responses into the baseband and IF paths so as to simulate various equipment degradations.

The first day is devoted to TV traffic impairments and the second to telephony traffic.

What else has been done?

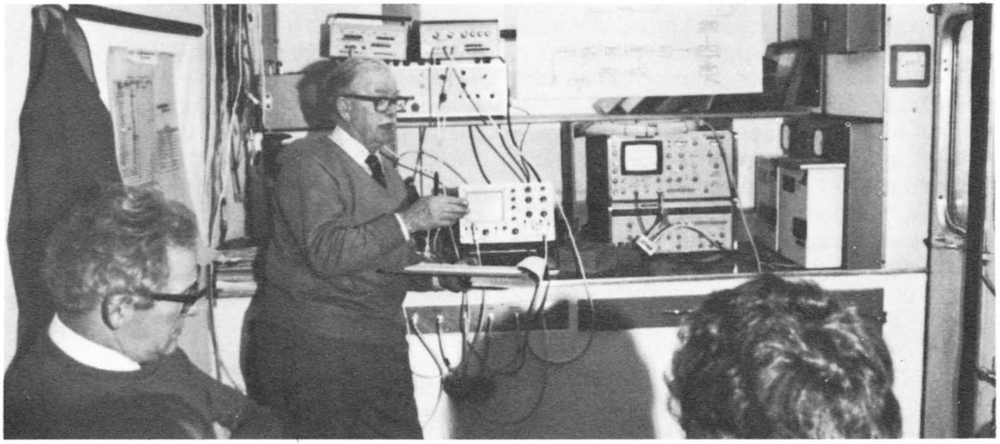
All staff engaged on the maintenance of microwave links have been issued with a personal copy of the 'Microwave Engineers Pocket Book'. This contains scaled down copies of the wallcharts mentioned above and other information of practical use in day-to-day work. The book is constructed to withstand the rigours of daily use and includes some blank pages for information which users may wish to add for themselves.

The high reliability of some equipment does not enable maintenance staff to build up much experience on fault finding and when the occasional fault does occur it can result in a time-consuming search through handbooks. The Pye and GEC TDM supervisory and control equipment come into this category. So for this we have recently devoted some special instruction sessions at the stations concerned.

Measures such as these bridge the gap between the formal courses offered at TTC Stone and the needs of day-to-day work.

The author has now been transferred to TD6.4.1. Enquiries about this article should be referred to Sv7.3.1 (01-432 1340).

The outside broadcast van



Instruction in progress

A call-monitoring equipment from Cardiff

by **Peter Bushell,** WMTB

Designed and produced in the WMTB Tester Design Workshop, this equipment helps the ATE maintenance officer to pinpoint 'blackspots' occuring due to exchange switching plant failures. It can be used at many access points throughout the switching network and permits service surveillance of local, STD and incoming trunk traffic. As the photograph shows, the equipment is divided into two sub-sections.

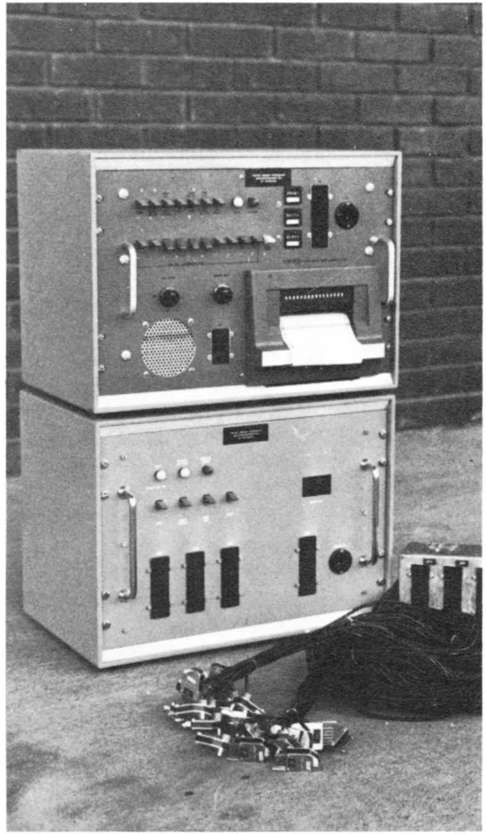
The motor uniselector access circuit
This is connected to the circuits under observation by flexible cords and suitable connectors. It contains a high speed motor driven uniselector to permit the monitoring equipment to be connected to the observed circuit within 100 ms of seizure. This is essential if subsequent dialled pulses providing routing information are to be recorded. The sub-section includes a high impedance pulse monitoring unit enabling dialled routing information to be stored and recorded within the 'no tone' detector equipment. Provision is also made to identify the circuit under test by means of an illuminated numercial indicator.

The no tone/NU detector
This is based on the Call Failure Detection Equipment no 1 (CFDE 1) and interconnects with the access unit by means of plugs and cords. It includes the same basic functions as CFDE 1 – tone detection unit, hold and trace, and so on, but there are a number of additions which materially improve its function. These are:

- Loudspeaker Amplifier
- Trace-tone facility
- Preselected first digit discrimination
- NU Detection
- Register/Translator Lockout detection (NU tone after third and fourth digit)
- Variable minimum digits setting.

The equipment is further enhanced by the association of an 'in-line' digital printout and indicating equipment. This permits a 'printout on failure' feature to be employed when required.

A typical use for the combined tester is when troubles are experienced at a point within a switching network, such as an incoming junction route. Up to 20 circuits can be monitored simultaneously, with the routing and result of each observed call being recorded. An analysis of failures pin-points the source of the troubles and permits speedy remedial action. Additionally, since details of all observed call routings are recorded on a paper tape, the equipment can readily provide patterns of traffic flow for trunking and grading purposes. Although specifically designed for use on TXS, it can



Cardiff's call monitoring equipment

be used with equal effect on TXE or TXK.

The design is based on electromechanical components and because of the large number of functions available and attendant components, it would be more accurate to describe the equipment as transportable rather than portable – the dimensions of the two cases are 482 mm × 300 mm × 290 mm each and they have a combined weight of 55 kgs. But this is a minor disadvantage compared with its value in locating sources of trouble that previously were time consuming and often inconclusive.

A quantity of the 'no tone/NU tone' detectors were made in the Regional Tester Design Workshop while the Motor Uniselector Access units were made by PO Factories.

Future development

A limitation of the Motor Uniselector type of access equipment is the hunting speed of the Motor Uniselector. This is adequate for most purposes but some difficulties have been experienced where the interval between pulse trains is shortened due to network switching requirements – for example, incoming first Numerical selectors from Discriminator Satellite exchanges. In these circumstances, routing digits can be lost during the access hunting period. To overcome this we've been designing an electronic equivalent of the Motor Uniselector, the prototype of which has already been completed. This provides a switched path to the observed circuit within 2-3 ms of seizure by the use of opto-couplers and TTL Integrated circuits, the actual search over the observed circuits being carried out some 11000 times a second. Plans are now in hand to redesign the 'no tone' detector and printing element which would make the whole unit electronic. Eventually, both subsections will be housed in a single small case that can be truly described as portable.
WMTB/SMD/S3.2.1.4 (0222 391 406)

Editor's note: The Tester Co-ordination Working Party, which includes representatives from each region, has decided not to adopt this equipment on a national basis.

Measuring private circuit performance –A new scheme

by **John Marsden,** Sv7.1.1

1978 sees the national introduction of a completely revised method of measuring private circuit maintenance performance. The present system came into being in the late 1960s. Although it introduced the concept of performance measurement for private circuits it has attracted increasing criticism in recent years. So in late 1976 a major revision was put in hand.

What is wrong with the present scheme?

- Its dependence on centralised data preparation and 'batch processing' results in an unacceptable interval between submission of data and receipt of analysis.
- Centralised processing also effectively rules out the correction of errors on fault dockets resulting in a disturbing seven per cent of dockets being unacceptable for processing.
- The monthly analysis does not readily answer all the questions which area and regional management wish to ask nor is there a procedure for analysis to be tailored to individual area requirements.
- The scheme does not readily lend itself to the production of area TIP achievements for the private circuit repair service.
- It is difficult to trace poor results back to specific fault reports.

With these criticisms in mind a new scheme has been worked out and has been subjected to wide discussion. It is based on the use of computer terminals in each area and provides for the direct entry of fault dockets to a central computer file. Weekly and monthly analyses are performed entirely by the computer. The scheme was presented to all areas in early 1977 in a series of regionally organised seminars at which a simple outline computer program was used to demonstrate its potential. The proposals were greeted with enthusiasm and an avalanche of comment and constructive criticism poured back to THQ which greatly assisted in producing the final design.

Programming has been carried out by the Scientific Computing Department of the PO Data Processing Service (DPS) to a specification produced by Sv7.2.2 working in close co-operation with Sv7.1.1 and Sv7.1.2. The final program was thoroughly tested by Sv D using simulated fault data.

What advantages does the new sheme offer?

- Areas and regions can obtain weekly analysis immediately they have completed input of data to computer files.
- Monthly analysis will be available within no more than two weeks following the end of the month concerned.
- The input program rejects dockets with errors and permits local corrections to be made.
- Detailed analyses may be selected from a wide range of options and obtained immediately *via* the area computer terminal.
- A poor result may be readily traced back to the docket or dockets responsible which can be listed complete with circuit numbers.
- TIP achievement figures can be readily obtained. A new performance index called TIP2A, derived in similar fashion to the public network service performance index TIP2, is to be introduced concurrently with this scheme.

We've taken this opportunity to revise all stationery associated with private circuit fault reporting and analysis. The number of forms involved have been halved. The principal change however is to the private circuit report form. Its size has been enlarged, not to increase the amount of information carried (there are in fact less entries) but rather to make it easier to handle, easier to complete and less difficult to read. One of the criticisms of the old form (A2911) was that it had to leave the fault reporting point (FRP) for several days while the weekly analysis was completed. The new form (A2051) produces a carbon copy which, on completion, carries the information required for computer analysis. This is detached and sent to the area clerical group for processing. The top copy, which includes the log sheet, remains at the FRP at all times. The form presently includes a disposable 'one time' carbon paper, but we are examining the possibility of using a carbonless type.

Before the scheme gets underway the service codes on all record cards will be changed from two to three digits. The additional digit permits more detailed analysis of the performance of specific types of service – data, intruder alarm and so on. This retrospective amendment is currently taking place through the direction of THQ circular E5/78.

A series of one day training courses for area engineering management has been arranged at the DPS offices in Kensington. These will teach how to obtain and use the various analyses available.

We don't intend to let this scheme stagnate. After introduction it will be closely monitored to ensure that the facilities provided are those which are of greatest use. Changes will be made if and when necessary. Already we are considering extensions to include International private circuits and to provide sub-control performance measurement and we are always open to suggestions for improvements from users.

The engineering procedures associated with this scheme are explained at length in *TI E1 C1160*. This replaces *E1 C1156* which deals with the old procedure.

Sv7.1.1 (01-432 9190)

Keyphones and MF signalling– Glasgow Area's tester

by **Bill Wright**, Glasgow area, EMS17

Over the past year or so the penetration of PABX systems using multi-frequency (MF) signalling from extensions has increased rapidly. In such systems the push-button unit on the keyphone is associated with a multi-frequency line powered oscillator. When a button is depressed two of these frequencies are sent to line – a different combination for each button. A difficulty in maintenance is how to prove whether signalling faults are with the SA4258 telephone or with the code receiver in the PABX equipment.

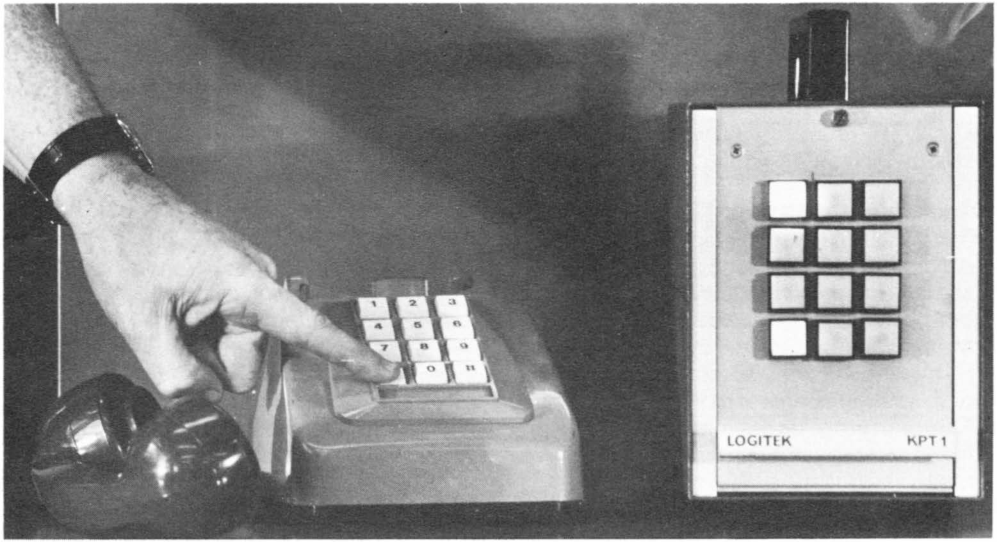
In Glasgow area we've overcome this problem by using a purpose built tester. It checks the functioning of the MF Keypad, giving a lamp display in a matrix form equivalent to the layout of the telephone's push buttons. Although designed primarily for maintenance purposes, the tester has also been a worthwhile aid on installation work – from 700 telephones tested we discovered an eight per cent failure rate.

The overall size of the tester is approximately 12″ × 6″ × 7″. It requires an external 50 Volt DC power supply. When in use, crocodile clip connections are made to the telephone's block terminal. A simple variable input compensating pad accounts for slight differences in the signalling characteristics between one manufacturer's telephone and another.

The tester's circuitry meets PO requirements for receiving equipment at PABX installations (POR 1151). Basically there are seven tuned receivers each working within 1.6 per cent of the nominated frequency. The appropriate lamp on the matrix display is lit when logic circuitry detects that the correct two of these frequencies are present. But beforehand, validity tests are made as follows:

- More than one frequency is present;
- Only one frequency from each of the high and low frequency bands is present;
- Both these frequencies have a power level in the range expected from the telephone;
- The signal to noise ratio is acceptable;
- The signal duration is greater than that normally produced in speech.

The advantage of having a matrix display



Glasgow's key pad tester

rather than a digital one is that under certain fault conditions a double display is given when only one button is depressed, whereas a single digit display could well mask this condition.

Other indications of a fault are:

- No display when one particular button is depressed;
- No display when any button in one particular vertical or horizontal row is depressed;
- The wrong display for a particular button;
- A flickering display.

And some of the faults revealed are:

▲ Wires off oscillator pad;
▲ Framing contacts at transformers;
▲ Components dry-jointed;
▲ Micro-switches S1, S2, S3 out of adjustment;
▲ Incomplete operation of crutch-hook micro-switch.

The tester provides a far more detailed analysis of the SA4258 telephone than the established testing procedure laid down in *TI E5 B2821* and, since the majority of faults can be quickly put right on site, gives scope for considerable savings.

A local electronics firm showed great initiative and enthusiasm in building it. The completed item cost about £225 in the Autumn of 1976. It has proved itself a worthwhile investment and, through daily use, continues to earn its keep.
STB/GWTA (041-220 2872)

Letters

... about call failure detection equipments.

The article in *MN10* on remote printout for CFDEs seems a strange answer to the problem of them not being used.

While I agree that having to analyse the tapes is a time-wasting job (the CFDE used in this mode is nothing more than a glorified TSO) the answer, surely, is to use it in the 'hold and trace' mode.

Admittedly, this increases the time spent on CFDE work at first, but to a good end, because every fault held and cleared gives an immediate improvement in service to the customer. After not too long, the general improvement brought by the 'hold and trace' method means that time spent on CFDE work is greatly reduced.
R C Brewster,
ETR/Oxford Area.

... about accommodation services

In recent years a lot of glowing publicity has been given to the heating and ventilating plant in PO buildings. Nobody has anything to say about the electric light and power (EL&P) group that maintains it. Is the PO ashamed of the state of this activity or is it ignored because it represents only two or three per cent of the whole Business, produces no revenue and affects only our working environment?

To do this work the PO recruits and trains telecommunications engineers. It uses a WU values system which is mostly ancient or non-existent. The PO make little attempt to standardise equipment. It seeks or expects no information to be recorded or monitored. The PO uses TIP 26 as its only guide which combines this maintenance (F2A) with cleaning. However, there is hell to pay if the radio station temperature is not properly regulated, and staff walk out if the General Managers' building environment and facilities are not right. The PO moans and wonders why it is difficult to attract staff to this exacting job.

How many £M's does the Business have to waste in terms of extra fuel, extra power and early plant renewals before it puts F2A (EL&P) Maintenance on a sound footing? Why not start straight away and give the job an appropriate name – my suggestion ... 'Accommodation services maintenance'.
R Murray,
ETR/Service Division

The writer has highlighted an area of work on which insufficient importance has been laid in the past at THQ, and in regions and areas.

Now that some cooling plant is system critical, because of the closer packing of new eletronic equipment, it is essential that cooling systems are designed, installed and maintained to a high standard of reliability. Much work is being done in THQ on things *such as standardising systems, selecting approved plant items, re-assessing maintenance work units and analysing fault records.*

Some of this work will come to fruition shortly and the results put into effect without delay.
OP6.3

. . . about reorganising area maintenance

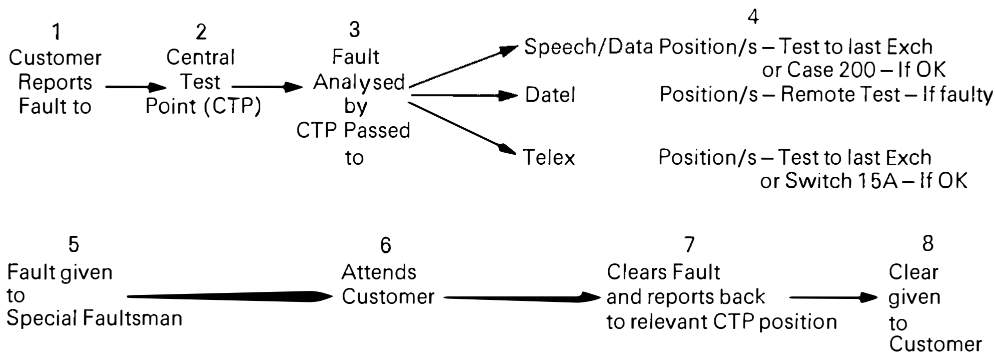
How about a specialist maintenance group for all private circuit faults?

I am particularly interested in the split maintenance problems which occur in a highly populated telephone area such as Birmingham, say, in the case of a large computer centre or a multi-combine firm. Here, speech circuits are normally handled by customer's apparatus and linesmen from the Repair Service Control (RSC), datel circuits are handled by datel field maintenance officers and telex circuits are handled by telegraph field mechanics. Various testing centres are involved, and the numerous 'phone calls which occur are likely to cause errors and misunderstanding.

Surely, a more reasonable set up would be:

- Local RSCs – processing all general customers' apparatus and line faults, as at present. This already works reasonably well under the 151 system.
- A specialist group of maintenance engineers, either centrally based or sectorised, dealing with all private circuits faults on the transmission line and at customer's premises.

The private circuit faults could be dealt with as follows:



By this procedure, multiple visits would be avoided and out of service time would be drastically reduced. Customer service would be considerably enhanced – which is what our chairman is continually crying out for!

P J Richie,
MTR/Birmingham Area (021-262 2134).

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 here. The editor cannot publish anything to do with current awards suggestions.

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