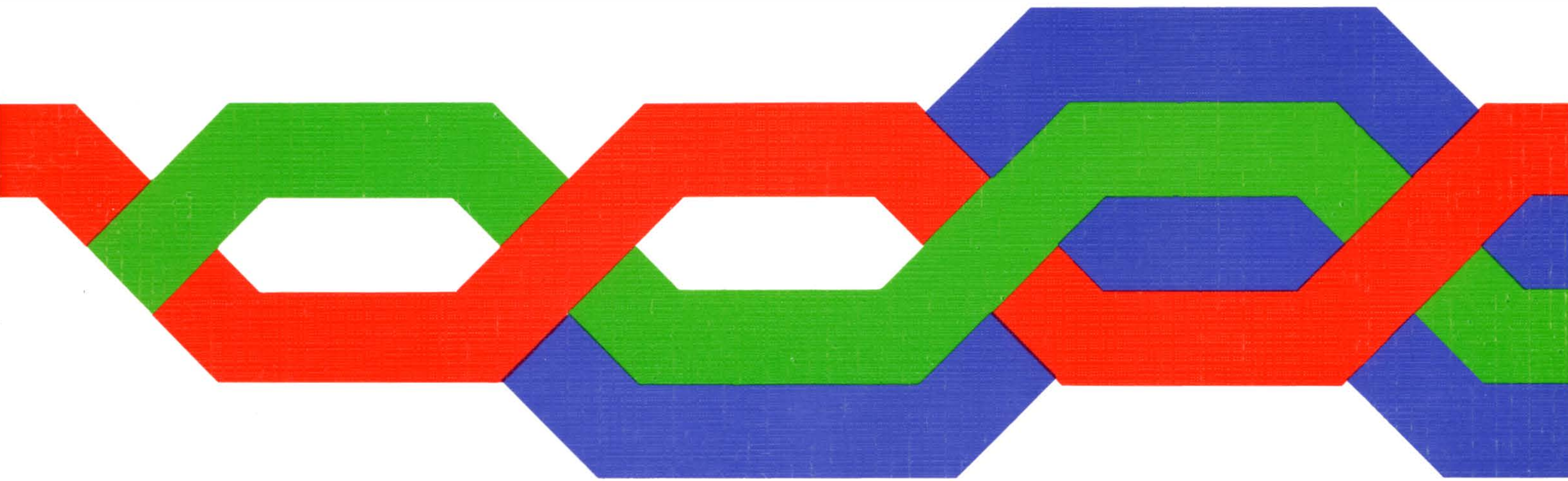
Post Office
Telecommunications

Maintenance News 5

Summer 1974



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Produced for SvD by THQ Internal Communication Unit

Editorial

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There has been a falling off in the number of letters to the Editor since the early issues. I am hoping this trend will not continue, because *Maintenance News* is meant to be a two-way channel of communication.

Many of you are phoning into the authors of different articles. This is fine, since it gets you early answers to your enquiries. But remember that others up and down the country may also be interested in the reply – the way to get it to them is to write to the Editor. When you write to me there is no need to pass the letter through your supervising officer, though in some cases it may be courteous to do so.

I am sorry that the spring issue was late again this year: this was due to difficulties in the supply of paper.

The Editor

Letters

Fault reports which prove RWT

Many years ago on the test-desk at Gerrard exchange in the LTR when a Repair Control Officer could find no fault he marked the card 'TOK' – tested OK. Then during a period of light traffic an exchange TO would collect these cards and test the common equipment which could be the cause of the fault report. For instance in the case of NDT he would test every outlet on the subscriber's uniselector for dialling tone. This method found quite a number of faults which could have eluded the RCO for a long time. It had advantages over the A1053 procedure in earlier clearance of faults and reduced paperwork.

– G H Rouse, NETR

The procedure Mr Rouse recalls is not in general use in the LTR and in most cases would involve TOs in unproductive extra testing work. As he implies, the A1053 procedure is the correct way to bring repeat faults to attention.

Sv 5.1.3 (01-432 1386)

Safety wear and protective clothing

I think the apathy towards safety wear and protective clothing is largely due to designers and manufacturers ignoring the fact that the items are meant for human beings!

For example, the safety helmet is uncomfortable and even cumbersome. The peak makes it quite dangerous in congested underground structures. Safety goggles are uncomfortable and make the face and eyes sweat. I suggest a new helmet of the 'all-in-one' design favoured by motor cyclists, which would in many cases obviate the need for eyeshields and be a boon to spectacle wearers.

Staff do not take advantage of the protective footwear scheme simply because of the prohibitive cost. In outside industry safety footwear is free and is worn. I suggest the free issue of at least two pairs a year.

As for protective clothing, PO designs are rejected because they are old-fashioned and ill-fitting. I suggest a change to the design of overalls used by the Army.

– D C Hunt, London SW1

The members of Experimental Changes of Practice Committee 1 (ECOPC 1), particularly the staff side, will be somewhat taken aback to learn that design and manufacture of protective clothing and personal protection equipment are thought to ignore wearers' requirements. The truth is that they are subject to joint consultation and field trials.

For instance, trials of new designs of combination overalls and dustcoats are currently in progress, closely monitored by the POEU members as well as the management side of ECOPC 1. And as for the fit, protective garments have to be roomy enough to wear over normal clothing. There is no need to tolerate ill-fitting articles: they can be changed and the next size up or down will usually be satisfactory. Really awkward individuals – in shape that is, not disposition – can be suited with made to measure clothing.
The amount of subsidy on safety footwear is at present under review with the POEU.

Experiments with peakless safety helmets and helmets with visors did not lead to helmets being worn more often and those with visors proved to have snags, particularly for overhead work. The PO are currently buying one of the lightest helmets on the market consistent with the protection required and now there are liners available for comfort and winter conditions (see TI M4 E3311, issue 2).

Eyeshields do of course add to the sweating problem in hot conditions; but new Eyeshields No 3 catering for modern spectacles and with soft plastic skirting for greater comfort are freely available as 'Small Stores'. Eyeshields No 5 are being introduced for general use where full eye protection is not essential.

In THQ we feel that staff resistance to safety wear is mainly a matter of self-consciousness, a very human factor indeed. In America staff habitually wear equipment of much the same design as ours.

– Editor

Test Desk

design trials at Newcastle-upon-Tyne

In recent years people up and down the country have been looking at their Repair Service Controls (RSCs) and coming to the conclusion that a radical change is needed. Newcastle RSC is probably the largest in the country, covering all 29 exchanges within the charge group – nearly a quarter of a million stations. Direct reporting had been in operation before the two year experiment with female repair service clerks was introduced, but a return to direct reporting took place in 1970 when this scheme was abandoned.

With a staff of 27 in the control it was difficult for individuals to feel any personal involvement and it became clear that a thorough overhaul of the arrangements, both within the RSC and in the organisation of the field staff outside, was necessary. The final proposal was to separate the supervision of exchange and field maintenance functionally: two AEEs were appointed to supervise exchange maintenance and field maintenance was split into territorial loads for four AEEs.

The level-151 traffic was split into four groups of circuits to coincide with the four territorial loads. The staff working on complaint reception and distribution duties were divided into four corresponding groups each with its own fault card record drum. In effect, since August 1971, Newcastle RSC has had four RSC units each with its own field staff and field supervisor – the RSC itself being supervised by its own AEE. In this way the economies of scale claimed for a large RSC have been retained as well as the self-managing advantages of the smaller RSC. The arrangement has worked well, and in the opinon of both local management and staff it is a considerable improvement over the organisation which it replaced.

The current accommodation in the auto exchange is, however, totally inadequate and in planning a new RSC in proper surroundings the opportunity has been taken for a fundamental re-think. At early meetings the staff had expressed their dislike of the traditional long line of test desks – not uncommonly located near the MDF or noisy equipment. Subsequent discussions indicated that a low, console type of test desk was needed, preferably in office type accommodation with an appropriate decor. The desks would be arranged in groups or small suites to suit the organisation.

In designing the test desk position the reduced height and face equipment area limited the amount of equipment which could be provided: key control in place of cords tends to use more space for apparatus.

Close liaison with Newcastle Area management and the POEU produced a schedule of facilities which could be accommodated in the space available. Further consultation with the Human

The new test desk design – smooth and uncluttered.

Factors Division in Res D followed, and finally a design emerged from which Factories Department, Enfield constructed a non-working mock-up. This model was taken to Newcastle for local comment: modifications suggested by the local people will be incorporated in the final design. A single working position will be installed and used at Newcastle for a short period before the final requirements are given to Factories Department who have agreed a programme and timetable for the construction of the first thirty positions.

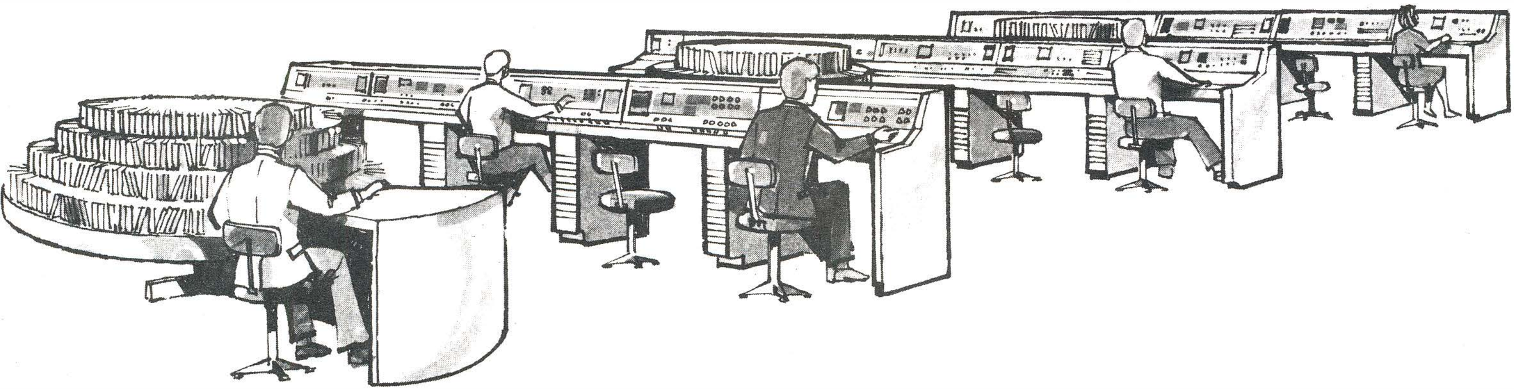
The desks will be installed in suites of five positions. Two will be used for complaint reception and two for fault distribution; the fifth position is intended to cater for both peaks and growth in the work of the group. When a number of fifth positions are permanently occupied local management will decide whether an additional team is required. The creation of a new four man team will mean that the existing five man teams will drop back to four and an additional field AEE post will be created. The territorial loads will then be redistributed and the 151 traffic rearranged.

At present it is thought that, at the maximum size of 50 positions allowed by the proposed accommodation on the fifth floor of the TMO building, up to 600000 stations could be handled successfully – assuming a drop in complaint rate to 0.6 or thereabouts.

It will be seen from the accompanying photograph of the single position mock-up that the new desk presents a smooth and uncluttered appearance. Only those facilities essential for the work to be done effectively have been provided and all circuits and facilities are key controlled: an electronic dial speed and ratio tester designed by Factories Department is being provided. All other design work has been carried out by NETR staff; and the Newcastle POEU members concerned have been consulted at all stages. It is hoped that the new centre will provide the congenial working conditions necessary for RSC duties to be carried out effectively.

NETR/S12 (0532 – 37698)

An artists impression of the proposed Newcastle, Swan House, Repair Service Control.



Managing the broadcast network service

On 1 January 1973 responsibility for broadcast network operations and maintenance was given to one THQ group, the Broadcast Network Management Group (Sv6.3.3). In practice the existing group responsible for TV vision services including occasional broadcasts was expanded to include sound transmission for radio and TV broadcasting. This article is intended to give a brief insight into the work of this group.

Although broadcast transmission is a small part of PO activities, its importance is greatly enhanced by being in the forefront of mass public scrutiny. Our quality of service is simultaneously monitored by millions of people all of whom are in contact with the same information source and who are immediately aware of any imperfections. While it is true that viewers and listeners cannot generally relate incidents directly to the PO network, the broadcasting authorities use sophisticated quality control methods to ensure that their customers receive the best possible service, and are therefore able to act as powerful reflectors of mass opinion.

In addition to the huge audience involved, there is the fact that broadcast sound and vision signals are very sensitive to transmission defects. Our own methods of quality assurance have evolved in the knowledge of this high degree of critique. Hence our present system of monitoring vision channels at strategic points on the network (Network Switching Centres–NSCs) during broadcasting hours–more intimate control than for any other service we offer.

The Broadcast Network Management Group is broadly responsible for giving the broadcasting authorities the best service possible, compatible with the facilities rented. Customer satisfaction is obviously dictated to a large extent by the actual measured service quality but the efficiency and speed with which we deal with problems also has an impact. We believe that personal contact with the customers, on the network as well as at THQ, is of prime importance in providing a satisfactory service.

Our activities can be listed as follows. We:

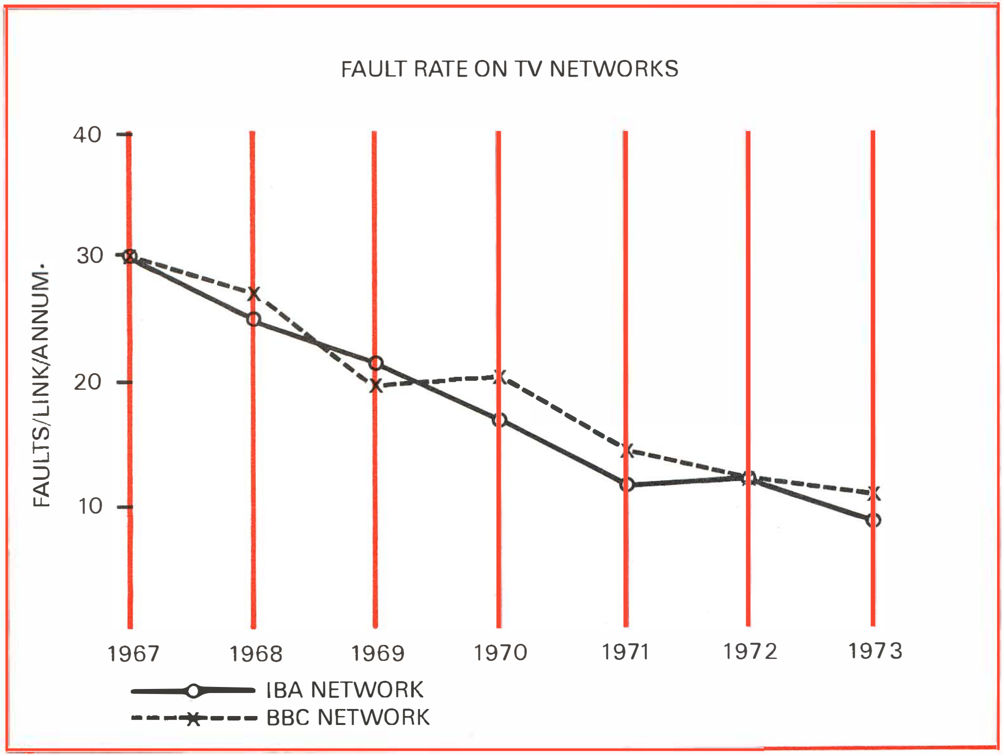
1 deal with customers problems and advise the ways of achieving the best service;

2 assist in resolving difficulties on the network, both short and long term;

3 control circuit and overall network performance;
4 formulate maintenance policy;
5 survey the network continually with a view to making improvements;
6 study proposed network changes and new broadcasting services to ensure satisfactory service quality;
7 process customers' inter-city occasional vision bookings and arrange appropriate connections;
8 over-see the TV outside broadcast service, technical liaison with customers and planning of large events.

The key to our success is quick and accurate information. For the sound and vision networks a system has developed which satisfies this need. Two methods of quality control are used; firstly our in-house routine maintenance techniques and secondly, the analysis of customer reported faults.

Assessment of service quality is based on customer reported faults. This is an accurate gauge because of the high standard of customer monitoring. The broadcasters not only detect short breaks, sound and visual distortions but are able to measure vision parameters continuously using automatic equipment fitted with remote alarms. The Network Co-ordination Centre collects and vets all broadcast network fault reports. Major event reports are forwarded to Sv6.3.3, normally within 24 hours. Minor fault reports follow the same procedure except that the last stage is allowed a longer delay. National statistics are produced from the reports on a weekly, quarterly and annual basis. Long term trends are shown and areas identified where improvements would have the maximum impact on service. Three statistical parameters are used for quality measurement; fault rate, lost programme time (LPT) and lost circuit time (LCT). Without going into the finer details the essential difference between the outage parameters is that the former



does not include time when service is re-routed on alternative plant. Individual links are compared to the national average. An indication of the improved service on the vision network in recent years is shown in the graph.

A speaker circuit between the management group and the TV Network Controller provides direct communication with the network; this is used where emergency action, the dissemination of urgent information and guidance on policy matters are needed. Video and sound channels to London NSC give access to the networks, and this allows test signals to be monitored and information to be transmitted as the need arises.

Routine maintenance, to a set of limits, is scheduled for each link. The limits are designed to be better than those used by the customers for fault reporting. The Group studies the recorded measurements and follows up any abnormal changes. An analysis of equipment faults, arising from customer reports and routine maintenance, completes the network quality control scheme. Statistics of various fault categories are used to identify problems with the aim of preventing a serious deterioration of the service.

The Group also plays a major part in the provision of TV occasional broadcast facilities. Protection channel bookings are processed and inter-connection of the required links arranged. Demand for this service has grown from a few hundred bookings each year in the mid-1960s to a current annual rate of 10,000 channels booked a year. It supervises TV outside broadcasts and co-ordinates major events, for instance general elections, state occasions and temporary CCTV networks, as well as liaising with customers on technical matters.

Changes to the network during the past ten years have included new operating methods and maintenance techniques. The TV network has advanced from two 405 line monochrome channels to the present three channels at 625 line colour standard.

Recently a new sound broadcasting service has been installed for IBA local radio; a network for transmitting BBC digital signals, providing 13 sound channels, is also being provided. Both are expected to grow rapidly in the next few years to become major networks in their own right.

A fourth TV channel may soon be allocated and in the more distant future digital transmission will probably be used for broadcasting. New testing methods may become available. How best to meet the new demands will form a significant part of our activities in the years ahead in addition to our task of further improving the high grade of service now offered to our customers.

Sv6.3.3 (01-432 1437)

Handling Electronic Items of Customer Apparatus

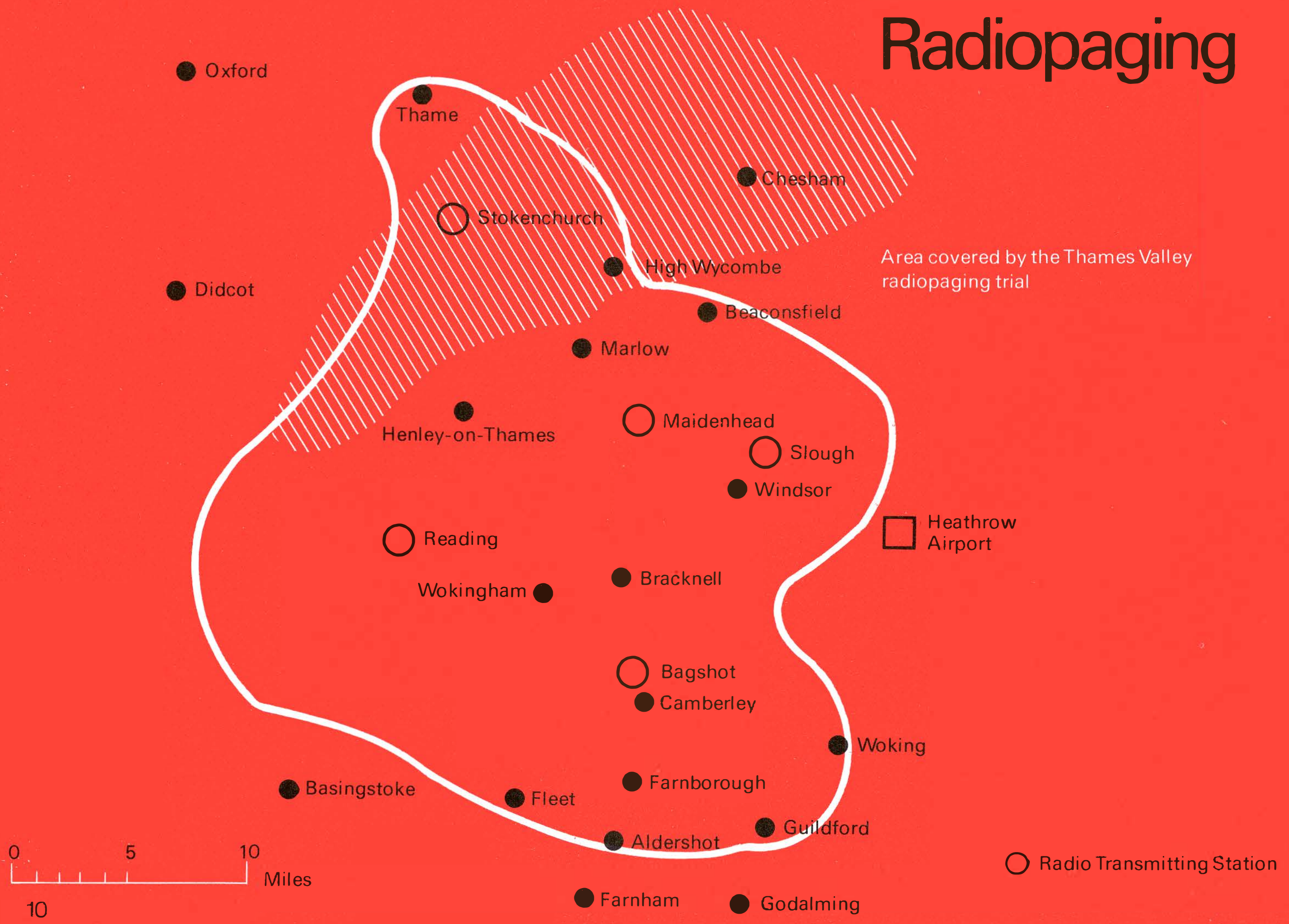
The ever widening range of facilities which we offer has led to more and more costly and complex electronic items being introduced into customers' apparatus. An example of this is the self-contained keyphone telephone, SA 4274 – costing five times more than a basic instrument – where modern technology has made it possible to replace the telephone dial with push buttons (see *Maintenance News,* issue three).

A limited quantity of SA 4274 telephones were put on trial in selected Areas two years ago. Because of the limited number of instruments purchased it was necessary to arrange for the manufacturer to repair faulty instruments. Examination of recovered telephones revealed instruments' insufficiently packed, some in plastic bags, others with no protection at all. From the total extent of the damage it was apparent that damage had also occurred either in fitting or recovery of the instruments, especially the push button unit and associated integrated circuits. Some appeared to have been damaged by screwdrivers.

May we remind maintenance staff of the need for care when handling electronic items of customers' apparatus. See, for instance, TI E5 B2800. Under no circumstances should attempts be made locally to clear faults on or repair the electronics; but if a fault is suspected on the electronics, the complete instrument should be changed and the recovered item carefully packed in the packing taken from the replacement item, before handling back to section stock stores.

Sv5.3.2 (01-432 5535)

Radiopaging



Commercial radiopaging systems have operated in the UK since the mid 1950's. Until 1969, when the radio regulatory function was passed to the Ministry of Post and Telecommunications, all these systems required a licence from the PO under the Wireless Telegraphy Act 1949. The licence restricts the operator to use the system only within the boundaries of his premises. These systems can usually cater for a few hundred pagers, that is paging receivers carried by the staff.

To page on these systems the caller contacts the system controller, normally a PBX switchboard operator, who manually sets up the controls of the system so that the wanted pager's coded signal is transmitted. If the wanted pager is within the hospital or factory premises it responds to the coded radio signal by giving some form of audible alarm. The person carrying the pager then contacts the system controller to establish the reason for the page.

Voice communications over radiopaging systems are not generally permitted in the UK, except at some hospitals that have a cardiac arrest team, where directions can be given over the system to members of the team so that they can assemble quickly at a desired location.

Public trials

The PO has, therefore, had an interest in radiopaging for some time and it decided to enter this field of communications. A number of commercial companies in North America have been operating city-wide type radiopaging systems for a number of years and in 1971 it was decided that a trial should be carried out in the UK using equipment leased from one of these companies. The trial would provide marketing and engineering information to assess the potential for a national radiopaging service.

The PO radiopaging trial offers customer facilities similar to the commercial non-voice systems with the added advantage that the service covers a larger geographical area, which could feasibly be extended to a national service. Paging calls are set up by the caller, who dials a ten digit number on the public switched telephone network (PSTN). The trial area covers about 500 square miles of the Thames Valley around Reading.

Equipment

The transmitting stations, which radiate 150 MHz paging signals are located at Bagshot, Maidenhead, Reading, Slough and Stokenchurch. Three of the key stations, Bagshot, Stokenchurch and Slough have automatic changeover equipment, which bring into service the standby transmitter in the event of a main transmitter failure. The Reading area has a back-up transmitter sited at the GSC, and the main transmitter is located at the top of a tower block within the town centre; both main and standby transmitters are operated simultaneously. All the transmitting stations are connected by land lines to the radiopaging terminal at Reading GSC.

The terminal, which transmits coded signals to all the stations, is computer controlled, and is designed to accept loop/disconnect impulses from the PSTN. The terminal currently comprises two identical Motorola "Metro 10" systems operating in a main and standby configuration with automatic changeover to the standby system should a major fault occur on the main system. The computers used in the terminal are the Digital Equipment Corporation (DEC) type PDP 11/15, which are 16 bit general purpose parallel logic processors using two's complement arithmetic. The total word capacity is modularly expandable from a minimum of 4000 to a maximum of 32000 words. Each computer has been provided with a memory bank capable of holding information on 4000 customers' pagers, but for the trial the capacity has been restricted to 2000 pagers.

The present computer configuration can be expanded to cater for 10 000 customers. By providing a quick access store of the disc type and some rearrangement of the terminal layout the capacity can be increased still further to 100 000 customers. Solid-state transistor – transistor – logic (TTL) circuitry based on integrated circuits is used throughout the terminal, with components assembled on epoxy glass fibre printed circuit boards.

Teletypes

Three teletypes are used in the trial, two are located at the terminal where one is associated with the main system and the other with the standby system. The third is situated away from the the terminal at the Radiopaging Control Officer's (RPCO) office; this machine is automatically connected to whichever system is carrying the traffic. Customers' pager information is entered and various service statistics are printed-out on the teletypes. The teletypes at the terminal can be used to load the software programme into the computers, and record the contents of the customer's table, held in the memory bank, on punched paper tape. A fault print-out is also available on the terminal teletypes, and indicates the type, location and time of failure in a coded form.

Alarm circuits on each system of the terminal are arranged to fall into one of two categories: major – which denotes that the fault disables the system and prevents it from further operation; and minor – which denotes that the system's performance has been degraded due to a fault. When a major alarm has been registered automatic changeover equipment transfers the service onto the standby system.

Maintenance and Repair

Maintenance and repair arrangement for the various parts of the paging system during the trial have been as follows:

Pagers. Except for battery changes, carried out by the RPCO, the pagers have been returned to the manufacturers for repair.

Transmitters. Maintenance and repair of the radio transmitters have been carried out by local PO staff with back-up from THQ.

Terminal. Both the computer and the teletypes have been placed under a maintenance contract with a commercial company (DEC). Other terminal equipment is maintained jointly by the PO and Motorola. PO staff operate the equipment on a day-to-day basis and carry out first line maintenance, that is fault finding to a faulty unit or printed circuit board. Spare printed circuit boards are kept at the terminal to replace the faulty ones, which are then sent to the manufacturer for repair or replacement.

Records are kept of all faults and repairs carried out by the manufacturers so that reliability can be assessed. These records not only help to estimate the expertise needed; they also show what in-house repair and maintenance arrangements would be required, were the PO to introduce the service nationally.

Sv6.5.3 (01-432 1301)

NCC News

This feature deals with various activities of Network Co-ordination Centres (NCCs) and general observations on the performance of the telecommunication network. It is hoped that NCC News will establish itself as a regular feature, but by way of introduction it may be of interest to give a bit of background to the NCC organisation.

Why NCCs?

The organisation was formed in 1968 to provide improved management information about the performance of the whole of the telecommunications network, with performance being looked at in terms of quality of service. The organisation was to enquire into any matters affecting service, and its operations were to be directed towards reducing service losses.

An NCC was established at each Regional HQ with a National NCC at THQ. It has always been emphasised that although each NCC comes within its own organisation, together they were to operate as a single entity. To achieve this they were provided with an omnibus loudspeaker network enabling information to be quickly disseminated nationally. And for speed, the organisation conducts most of its business by telephone – therefore avoiding paperwork. By the end of 1968 each inland Region had a working NCC and later one was introduced in IMTR, having its closest contact with the National NCC.

What do they do?

Full details of NCC functions are given in TI E1 D6025, but briefly their basic function is to monitor the quality of service being provided. This is done by collecting information regarding events and activities which cause major interruptions to service – for instance breakdowns and planned works. The NCC organisation was not conceived as a first line maintenance organisation and is not involved with fault localisation and clearance. But it is concerned to ensure the restoration of service and because of this, gives advice on available re-routes for hypergroups using the Service Protection Network (SPN).

NCCs were given the responsibility to control interruptions caused by planned engineering operations, with a view to reducing the effects on service. They subsequently took over the job of issuing advices of work on the HF network – full details of this procedure are given in TI E1 A1457.

NCCs also monitor the performance of certain special circuits, for instance television links and broadcast programme circuits. And they are also concerned with the security of air traffic control circuits, the British Gas first tier network and CEGB mains independent circuits.

Major failures of service must be reported to NCCs by the various plant and circuit controls. Details of what constitute major failures are given in TI E1 A1500 and these cover radio and coaxial link failures, terminal translating equipment failures where they affect large numbers of circuits, the isolation of exchanges and failures which cause a large restriction to customers' service.

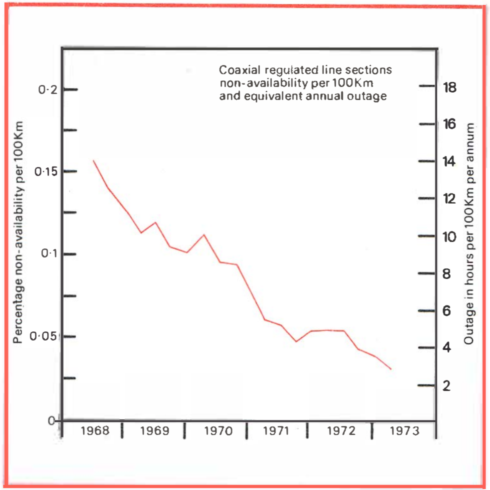
How do they work?

Breakdowns: when a Regional NCC receives a report of a breakdown it announces it over the loudspeaker network. So all NCCs are then aware of the situation and can assess how it affects their own stations. If the report, or subsequent reports, indicate that the situation will last for some time, then ways of restoration will be considered. This usually requires the NCCs to co-ordinate activity between stations in different Regions. All information is checked and passed to management and specialist groups at Regional and THQ level for consideration and action which may be taken before the fault is finally cleared. A simple record of each event is kept by the NCCs in docket form which gives dates and times, the service effects in terms of losses of numbers of hypergroups, groups or circuits, details of the faulty plant, and a section for a brief description of the cause and the ways in which service was restored and the fault cleared. The National NCC receives about 2500 reports of major failures each year affecting telephony. There are about 500 which affect television.

Planned works requiring NCC authorisation. Each proposal is studied to ensure the minimum disruption. On occasions, it may be possible to arrange for work in different places to be done concurrently, or it may be possible to suggest alternative routings that are not known by the originators of the request. When the work causes circuits on the HF network to be out of service, the National NCC arranges for formal advice to be circulated. For convenience, advices are prepared, duplicated and distributed by NP 1.4.3 at Oswestry who receive the details from National NCC by facsimile transmission. In 1973 the NCCs authorised 2900 jobs of which 970 required formal advices issued from Oswestry, 320 required advices issued from Area Circuit Provision Controls and about 100 were considered urgent, where advice was given to circuit controls by telephone or telex. The remainder – about 1500 – involved only momentary interruptions, for which advice was telephoned to major controls only.

What is done with the information?

It will be evident that NCCs accumulate much information about the things that affect the telecommunications network. This information is used to prepare periodic summaries and analyses. Regional NCCs do this to suit their requirements and national analyses are prepared by National NCC and circulated within THQ and also to Regions. Nationally, these statistics are used to, firstly, indicate performance trends on the existing network, secondly, to indicate possible performance criteria for future networks, thirdly, to assist planners of future systems and, finally, to provide information in connection with various economic studies.



As an example of a trend in performance, the graph reproduced here shows how the service lost because of failures of coaxial regulated line sections has fallen since 1968 when the NCCs started keeping records. To take account of the growth of coaxial links during the period the time lost has been expressed as the percentage non-availability per 100 km of regulated line sections – RLSs – in service at the time. The 1968 figure of 0.16 per cent represents a loss of about 13.7 hours each year, each 100 km in service, and the latest figure of 0.035 per cent is equivalent to about 3.2 hours each year, each 100 km. So over the whole period there has been something like a 75 per cent reduction in outage per 100 km. A detailed analysis has shown that whilst all aspects of performance show an improvement, the major contributing factors are a reduction in cable failures attributable to human activity and a reduction in the failure rate of transmission equipment. Coupled with these is a reduction in the mean outage on cable faults as a result of increasing use of SPN facilities.

NP 1.4.5 (01-357 2241)

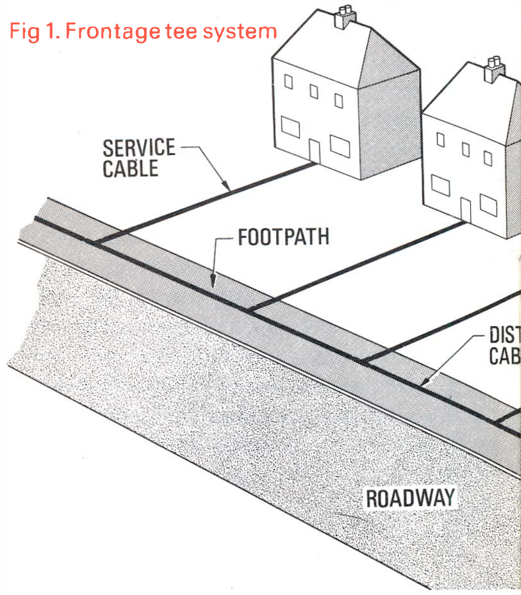
Radial system recommended on housing estates

Overhead distribution is the PO standard method of providing telephone service on housing estates. But this is often unacceptable to local planning authorities or estate developers who ask the PO to provide a completely underground distribution system. The piecemeal provision of underground distribution to individual houses as and when the tenant wants telephone service is not practical as it would entail repeated disturbance and re-instatement of footpaths and private gardens so it is necessary to provide underground cables direct to each house on the estate during the period of the estate development, irrespective of whether or not the tenant will ever want telephone service.

This widescale provision of telephone cables at an early stage costs more than overhead distribution and the PO only agree to such requests if the estate developer is prepared to make a contribution towards the extra cost involved. Most developers and builders prefer to make this contribution in kind, rather than in cash, by laying the service cable from each house to a selected point on the frontage where it will be jointed to the distribution cable, leaving a coil of cable to reach the actual joint position. The PO readily accept this help because it means that staff can be released for other work. As well as allowing the service cable to be laid in a pipe through the foundations of the building direct to the point where the telephone will most probably be required, it is also convenient for the builder as he can often lay the cable in a trench used for other services, such as water supply. The armoured or protected polyethylene sheathed service cable contains polyethylene insulated copper conductors and is filled with petroleum jelly to prevent water getting in.

When the External Planning Group in an Area plans the cable layout on an estate, the planner must determine the sizes and routes of the polyethylene sheathed distribution cables, the number of joints and their positions. The answers to these are mainly dependent upon whether he uses the radial distribution system or is compelled by special circumstances to use the older frontage tee method.

Fig 1. Frontage tee system



The frontage tee system – see fig 1 – was originally the most widely used. With this system the service cable from each house is teed to the distribution cable at a convenient point outside each house, and a separate buried joint is made for each individual or pair of service cables. Various ways of closing this tee joint have been used in the past. The current method uses

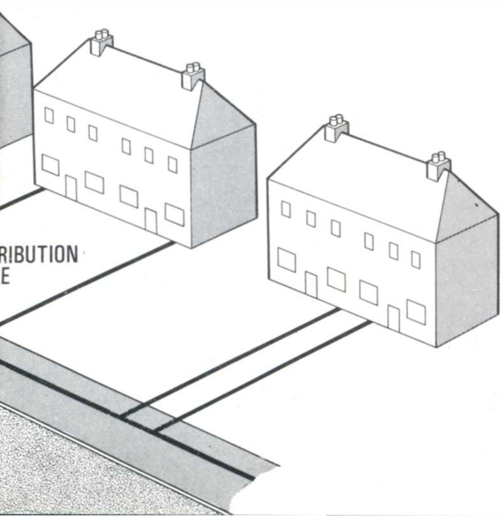
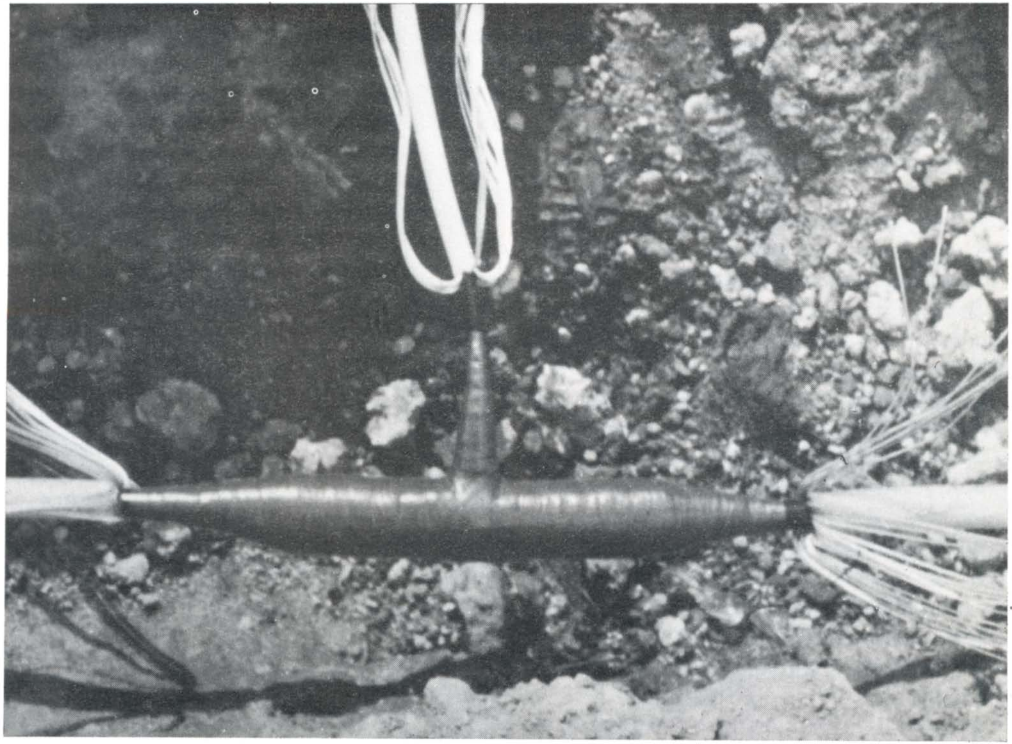


Fig 2. A Sleeve Polyethylene 41.



the preformed Sleeve Polyethylene 41, – see fig 2 – for one service cable, or the Sleeve Polyethylene 42 for two cables. The whole sleeve is wrapped with tape and protected by a metal plate secured to the armouring wires or protective over-sheath.

With the radial system – see fig 3 – the service cables from a number of adjacent dwellings are laid to a convenient point where they are jointed, in a common joint, to the distribution cable. This may either use a jointing post – see fig 4 – or an underground joint in a Sleeve Polyethylene 31A – see fig 5 – housed in a joint box. In the case of the jointing post no sheath closure is required as the crimped conductors are kept above ground level but in the sleeve 31A joint the cables are sealed into the base unit with a quick setting polyurethane resin. The crimp-jointed

Fig 3. Radial system

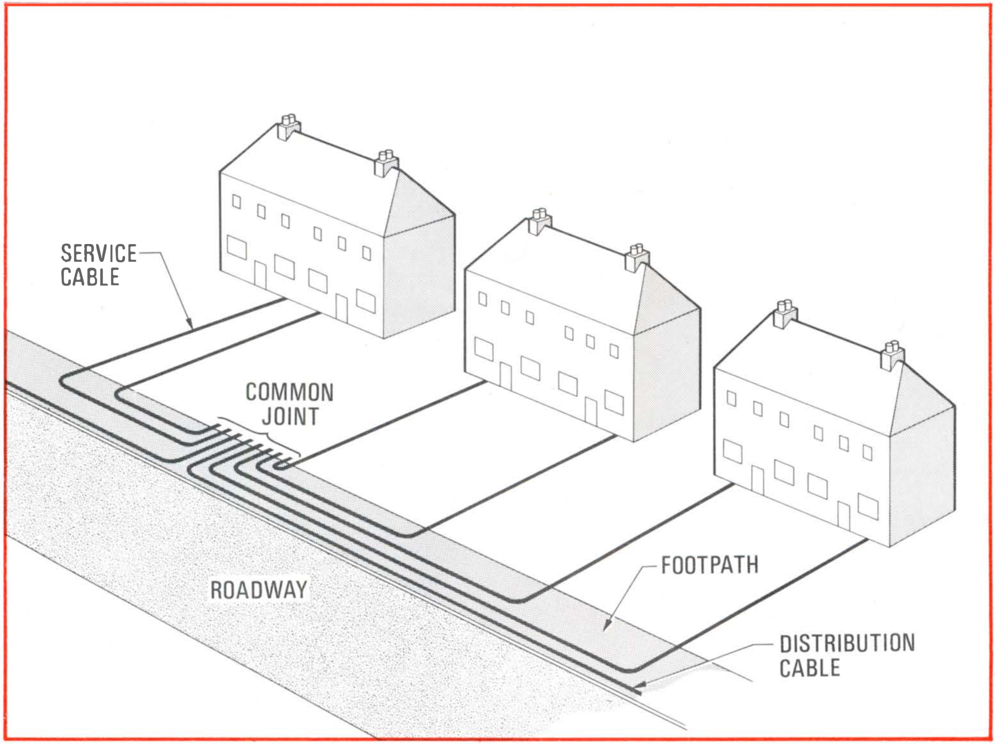
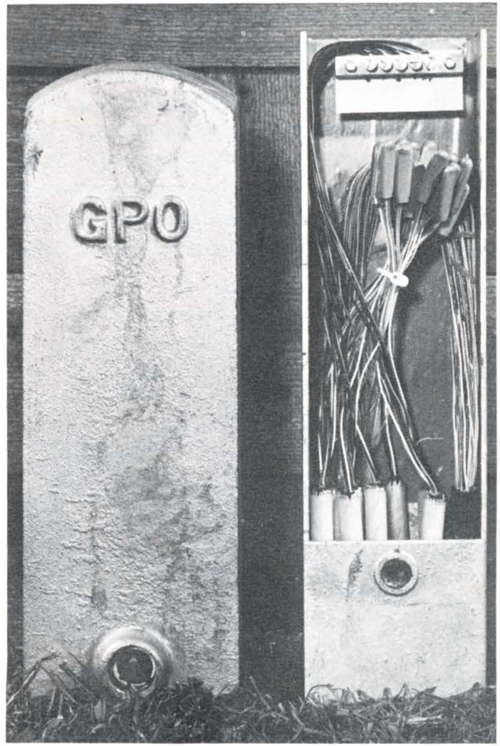


Fig 4. Jointing post.



conductors are enclosed under a domed cap which is clamped on to the base unit by means of a hinged clamping collar, a rubber 'O' ring forming the seal between the base and the cap.

The distribution cables, like the service cables, are filled with jelly, are wire armoured or protected and will in the future contain aluminium alloy conductors. They radiate from a cross connection point and are buried directly under the footpath or grass verge alongside other services. They are usually installed by moleplough or mechanical excavator.

The first authority to lay plant has the advantage of a clear run but risks possible damage when other services are laid. To reduce this risk, it has been agreed that PO cables will be laid nearest to the roadside kerb. And a further measure, which will reduce the risk of damage, as well as saving money, is to install plant of two or more services in a common trench in a single operation. Joint trenching schemes under which PO and electricity low voltage cables are laid in a common trench have been successfully carried out and further schemes are being planned in many Areas. With these schemes, negotiated by the external planning group, the

Fig 5. Sleeve Polyethylene 31A.

overall cost is shared by the PO and the Electricity Board.

While an estate is being built, there is need for considerable liaison between the builder, the PO and other authorities. This is to ensure that the plant is being installed as planned at the right time, and that stores are available to the builder when required to enable him to meet his obligations. And it is for these reasons that members of the external works staff, known as Estate Liaison Officers (ELOs), are appointed to maintain on-site liaison, each with responsibility for one or more housing estates.

Most underground faults on housing estates are caused by either mechanical damage or the failure of a joint closure. Both are repaired in situ. Locating the exact fault position is often difficult, especially when access to the termination in the dwelling cannot be arranged. But the introduction of the Locator 6A – see *Maintenance News* No 2 – will help the faultsman jointer to track the cable route and pinpoint the exact fault position.

Joints between the service cables and distribution cables on housing estates have always been a potential fault point. This is partly because of difficulties in making an effective buried closure in the muddy conditions which exist during building, and partly because of the tension applied to the joints if the cable is pulled by a mechanical excavator or the soil sinks due to heavy vehicles crossing the cable run.

The radial distribution system reduces the number of joints, enables joints to be made above ground level, and also provides easy access for testing if the house is unoccupied. Although radial distribution systems increase the length of the service cables the extra cost of this is offset by improved service and reliability. Because of these advantages, it has been decided that the radial system using either the jointing post or sleeve 31A as a common joint will now be used wherever possible.

Sv5.1.1 (01-432 1378)

Cleaning London's Exchanges

Dust and dirt are well known enemies of telephone exchange equipment. For more than 40 years the battle to keep London's exchanges clean has been waged against Hitler's bombers, building contractors, manufacturers' installers and too often our own construction and maintenance staff. In many buildings the battle seems to have been lost and the piles of dust that has blown in or been carried inside has an adverse affect on both staff amenities and unit performance. While we try to stop any more entering, there is an urgent need to prevent what has entered from infiltrating relays and selectors, so causing faults. The front line troops in this battle to protect our equipment are at present a force of cleaners often carrying out an ill-directed campaign with inadequate weapons.

The new LTR campaign

Following joint staff and management studies, recommendations have been made which will revolutionise exchange cleaning in London. Tactics are to be changed, and weapons improved. In the forefront of the battle we shall have two-man cleaning parties; these will be responsible for cleaning walls and high level areas. They will apply specialist treatment to modern floors. And special equipment will enable the resident cleaners to play a more effective role in keeping the exchange clean. The load for these men will be carefully planned and programmed: standards for times and work periods will be agreed and will take into account the new range of tools that are being provided.

New weapons

The two-man parties will have cleaning equipment and a van. Armed with extending ladders and folding steps the cleaners will clean walls and above racks. They will use commercial vacuum cleaners, scrubbing machines and wet pick-up machines for general cleaning. The wet pick-machines pour liquid over the floor area but as the process is so effective there should be no risk of damage to exchange equipment. If the floors are not treated then the dust rising from the break-up of the hard wax polishes will most certainly eventually cause faults on equipment.

Sweeping clean

The resident cleaners will be asked to throw away their dirty rags and brooms and will be given suction polishers, large span sweeper mops, lint-free dusters and lambswool dusting mops. The mops, to be used instead of brooms, are suited for sweeping rack bases and under guard rails. They have washable covers which are to be sprayed before use with a dust retaining fluid. The suction polishers to be supplied will also pass under guard rails.

Education

Part of our present cleaning problem is the lack of know-how among cleaners and their supervising officers and the introduction of new tools and methods will be valueless without an educational programme. A generously illustrated handbook will be issued to all cleaning staff. A separate supervising officer's handbook has also been prepared containing the information needed to prepare cleaning schedules and methods of operation. The involvement of supervisors is vital. They will need to review all cleaning loads using the standard times and periodicities, obtain the new tools for their staff and then ensure that they are properly used. A follow-up action with local training courses may also be necessary.

The objective

Greater efficiency of our cleaning activities, cleaner working conditions for staff and an ultimate reduction in the fault rate of our automatic exchange equipment should result from the introduction of these new measures.

LTR/Sv2 (01-587 7942)

Subscribers Meters
New performance statistics

Procedures for maintaining subscribers' exchange meters are described in TI E6 H0010, and are aimed at ensuring that the subscriber is not overcharged and the PO recovers the full revenue due for dialled calls.

Although the performance of exchange common equipment metering circuits shows up in Telephone Service Observation results, surprisingly little has been known of the in-service performance of subscribers' meters and their individual circuits. However, this gap can be filled, using information which is readily available – though not previously collated – from two forms in common use at all automatic exchanges. There are two forms which advise Telephone Accounts Groups (TAG) in Area clerical divisions of meter registrations resulting from engineering work and which must be credited to the particular subscribers' account. These are firstly form A3218, which must be completed when a routine test or patrol activity results in a meter fault being located and cleared, and secondly form A3732, which is a request from Area Traffic Division or TAG for a special test of a meter because of a disputed or diverted account.

The measure chosen for the new statistic is fault rate, and is defined as the number of faults found to affect correct registration of meter pulses in normal service for each 1000 exchange connections each year. The faults are classified separately, as Overmetering, Undermetering and No metering. Each classification is subdivided between faults attributed directly to the meter and those occuring in the meter circuit. Thus six separate fault rates are obtained.

Whenever a metering fault is suspected a minimum of five test calls must be made over the calling equipment before commencing any diagnostic work. These test calls must establish whether operation of the meter would be affected in normal working conditions. This is very important because TAG has to assess whether the bill should be adjusted. But TAG cannot make a decision on the basis of results obtained from meter test equipment alone, for testers are designed to impose more stringent conditions on the operation of a meter than are encountered in normal service. This is done to show up meters which might soon fail unless given early maintenance attention; thus failure of a routine test cycle does not mean that the meter will necessarily misoperate in normal service.

After the five test calls have been made and the meter registrations checked, the first requirement of the new statistic can be met – the meter can be classified as over-metering, under-metering, no-metering or OK in normal working conditions. Later, when the cause of the error has been investigated, the second requirement can be met – the fault can be attributed either to the meter itself or to the subscriber's circuit between the meter backing earth and the point where the circuit becomes common to other sub-

scribers.
Most of this is established practice, but so that this information can be presented in a way that will allow a summary to be easily and quickly made for the purpose of calculating the new statistic, a small panel has been added to each of the two forms A3218 and A3732; the engineer dealing with the fault can complete the form as shown in the following examples:–

Result of "Working Conditions" test	
~~*No metering~~	~~*Meter fault~~
~~*Under metering~~	~~*Circuit fault~~
~~*Over metering~~	*OK (working test)
*Delete classifications not applicable	

Metering OK under normal working conditions.

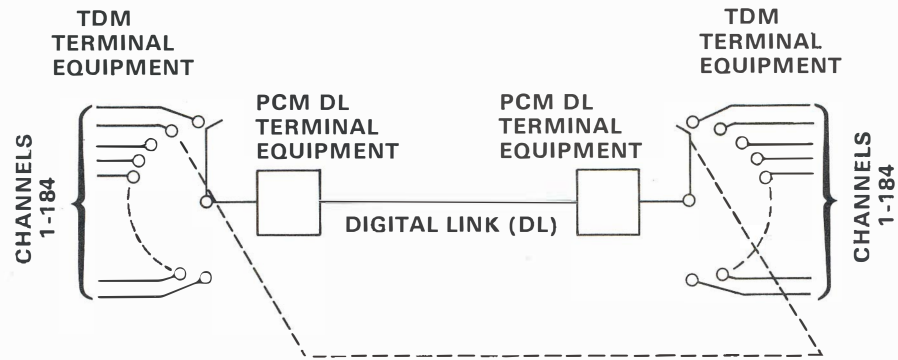
Result of "Working Conditions" test	
*No metering	*Meter fault
~~*Under metering~~	~~*Circuit fault~~
~~*Over metering~~	~~*OK (working test)~~
*Delete classifications not applicable	

No metering, meter fault.

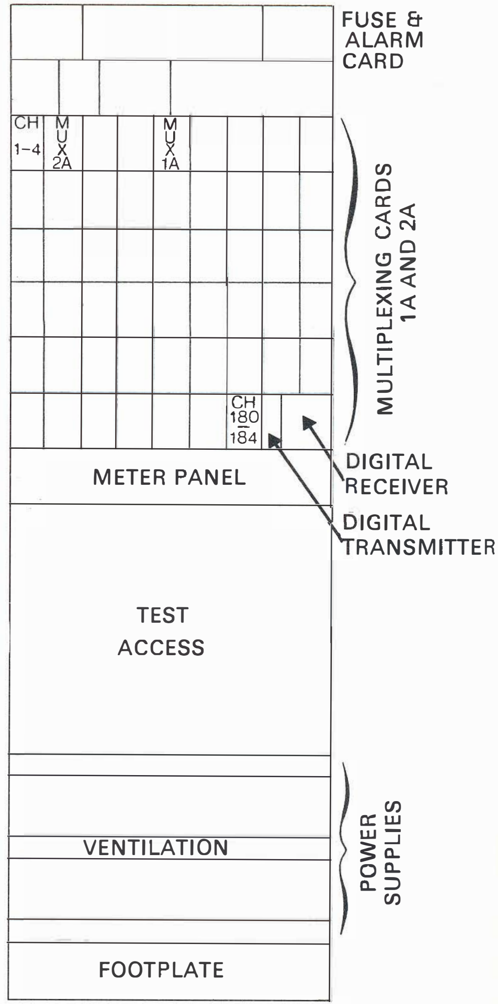
When the forms are completed, they are passed to the Repair Service Control where fault details are extracted for entry on the subscriber's record card and then to TAG through its central summarisation point where a stroke record is kept for each type of fault category for each exchange in the Area. At the end of a quarter Area totals for each fault category and the average number of working exchange connections are sent to RHQ to be collated with similar returns from the other Areas. Regional indices are calculated and the results sent to THQ for further collation with other Regions to produce National statistics.
From these figures, SvD are able to relate the level of faults found as a result of disputed or diverted accounts to those found by routine tests. The effectiveness of current maintenance procedures can then be assessed objectively and the information can be used as a guide for future maintenance.
As a monopoly business concern the PO has an obligation to give each customer full value for what he pays – he cannot take his custom to a competitor. If meters are under-maintained he is either overcharged or revenue is lost; over-maintain and costs rise, perhaps to be passed on to the customer in higher tariffs. The statistics will help to maintain the necessary balance between these two extremes.
Metering errors, though infrequent, tend to favour the customer which, within limits, is as it should be – the statistics show that for every case of overmetering due to the meter or its circuit, there are four cases of undermetering and eight of no metering at all. A proposed feature in the next issue of *Maintenance News* will highlight the causes of faults that lead to these errors.

Sv6.5.5 (01-432 9037)

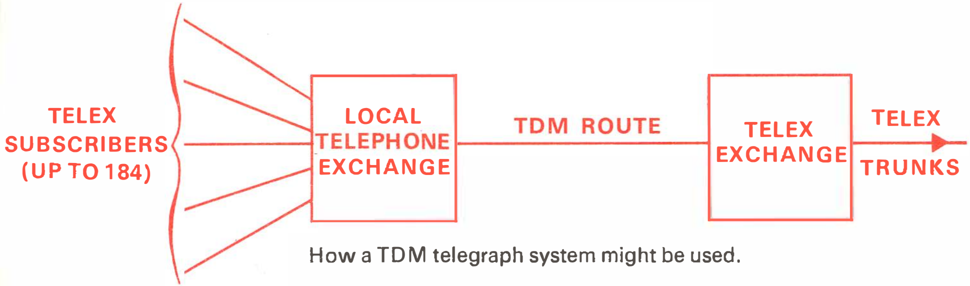
Time division multiplex and the telegraph network



A simple analogy illustrating synchronisation of the TDM terminals.



Rack layout of the field trial terminal.



How a TDM telegraph system might be used.

With the introduction of PCM (pulse code modulation) into the telephone network, an avenue was opened for a digitally multiplexed telegraph system. In simple terms this means a system whereby a number of telegraph circuits are combined or multiplexed into time slots, instead of frequency slots as at present, with the resulting signal being passed over a PCM digital link.

The PO successfully tried out the idea using a PCM link between London Fleet and Welwyn Garden City. The system provided up to 184 telegraph channels, time division multiplexed into a stream of narrow square pulses suitable for transmission over a 1·5bit/s digital link.

Each telegraph channel is sampled in turn for a short period of time, and the condition of the channel at that precise time, ±80V or disconnection is remembered, converted into a 2-bit binary code (space =10, mark =01 and a disconnection = 11) and arranged to form a stream of pulses and no pulses for transmission as a bit stream over the digital link.

At the receiving end, providing the equipment knows when sampling started for a particular channel, gates associated with each channel can be opened and closed to coincide in time with the channel being sampled. The opening of a channel gate to coincide with that channel being sampled at the sending end provides synchronisation. (See figure 1).

The equipment is housed in one 62-type 9ft 6in rack and consists of 46 channel multiplexing cards, each card handling four telegraph bothway channels (MUX 2A), six shelf multiplexing cards (MUX 1A), a transmit and receive line card, test access facilities and auxiliary cards including power supplies. (See figure 2).

The success of the initial study project led to a field trial between Reading and Maidenhead. The aim of the field trial is to evaluate the maintenance techniques needed on this equipment and to assess other general problems.

One important addition to the field trial is alternative-routing with automatic change-over in the event of a failure on the main digital link. Successful conclusion of the field trial will lead to the inclusion of TDM systems into the local telegraph network serving telex exchanges, according to economic demands. (See figure 3).

If you would like to know more about how TDM works, a simple but more detailed explanation is available from this group.

Sv6.4.2 (01-432 1316)

Private switched networks pose new maintenance problems

The demand for private switched networks tailored to provide communications between administrative headquarters, factories and operational sites for large commercial groups of companies, the nationalised power industries and public corporations is increasing rapidly. Not only are large companies linking up their existing sites, but in the present climate of Government subsidies to assist decentralisation from London, an added impetus has been given to the demand.

The organisation of PABXs into a network poses new problems for PO maintenance. While our privilege preserves PO maintenance for PABXs this does not extend to private circuit automatic tandem exchanges (PCATX). However, if maintenance responsibilities were to become mixed, the quality of service given by the dial network would suffer. Customers appear to recognise this and look to the PO to maintain their new tandem exchanges.

The initial step in designing a network is to take traffic records on the use of the public network for inter-company traffic and on the existing inter-PBX network; this can be carried out by the customer or the PO. If the PO carries out the study several alternative network plans are drawn up taking into account any factors which might change the traffic pattern in the future, such as restructuring of the company organisation, company growth and the traffic increase that would arise from the stimulus of faster and more direct communications. The PO issues to the customer a Telecommunications Advisory Service (TAS) report and in due course after consideration of our recommendations, or those from a private consultant or manufacturer, a network configuration is adopted. It is at this stage before plans become too advanced and firm orders have been placed for PCATXs that we like to see consultations started with Network Planning Department and Service Department.

Unfortunately some customers do not approach the PO early enough. They commit themselves to a basic network design, including proprietary tandem exchanges, before important parameters with a fundamental bearing on service and maintenance aspects have been considered. Among the more important points which require careful scrutiny are the transmission plan; signalling systems and the possible need for pulse regeneration; whether a secondary dial tone is required and its effect over the network; surveillance of the operational state of the network; fault reporting procedures; maintenance aids and the provision of alarm extensions. Each network presents different problems due to the variations in its basic design and the switching and signalling systems used both within the transit network and out to the peripheral exchanges, which will largely be existing manual and Strowger PBXs.

The list is continually growing but already the different types of plant that may have to be welded together into single networks are:

PABXs and PMBXs
- PO rented Strowger nos 1, 2, 5, 6 & 7 and PMBXs.
- Customer-owned Strowger nos 3 & 4.
- Customer-owned proprietary common control exchanges from four different manufacturers.

PCATXs
- Strowger and Rotary Controlled Motor Uniselector (RCMU), 2-wire switched.
- Common control from two different manufacturers, 4-wire switched.

Signalling Systems
- (i) Transit network 2-or 4-wire switched – SSDC no 5 (E&M) out-band 3825Hz in-channel on wideband groups. Multi-frequency (MF) CCITT R2 system, modified for national working.
- (ii) PCATXs to PABXs –
  - SCDC, SSAC no13 2280Hz on tariff 'S' circuits – 2-and 4-wire systems.
  - Loop disconnect.

Star networks with a single tandem exchange switching traffic between peripheral PABXs do not pose special maintenance problems if the junction routes are used in a bothway mode. On the other hand linking two or more tandem exchanges, maintenance problems arise with the introduction of a transit route. Unless the intermediate plant providing switching, signalling and the transmission path is kept under regular surveillance, either manually or with automatic maintenance aids, the quality of service declines until the customer is alerted by excessive call failures. Maintenance difficulties are also accentuated where tandem exchanges have a facility to route over an alternative transit path if a fault or congestion is encountered.

Tandem exchanges with co-sited PABXs linked by 12-circuit transit routes offer networks that can be manually tested provided that the necessary access is given and circuit occupancy displayed. However if a network has isolated tandem exchanges or large transit routes up to supergroup capacity (60 circuits) then automatic maintenance aids must be provided to observe the operational performance of the system.

Operator controlled networks

The first large private network to be equipped with PCATXs came into service two years ago – a 4-wire switched network with fast MF signalling between tandems, with operator controlled transit traffic. The tandems are crossbar common control exchanges equipped with second attempt facility through the switching matrix. Registers select an alternative routing when the first direct choice is busy or out of order. Service supervision equipment is installed at each tandem so that the quality of service can be observed. Service standards within the switching matrix can be pre-set: if the standard is not met an alarm is given.

With common control exchanges the tracing of call failures is impracticable. Suspect equipment can be functionally tested if facilities such as blocking keys are provided to enable a specific path through the exchange to be chosen. Meters are required to record total traffic and congestion, and these can either pan the complete exchange or monitor pre-selected routes. Where transit routes (typically twelve circuits) are selected cyclically it is possible to use a manual method of checking serviceability from a co-sited PABX. Twelve test calls during a period of low traffic can check a route with 90 per cent confidence.

Such networks, although not providing fully automatic extension-to-extension working do use 4-wire switching with fast transit signalling; and using service supervison equipment as well as manual routines, they can be kept under surveillance.

Fully automatic networks

A fully automatic network needs additional maintenance aids to monitor its switching, signalling and transmission functions. To keep transit routes between PCATXs under surveillance both the customer and maintenance staff must be able to gain automatic access to a nominated circuit. To do this, test selector access is required. On Strowger PABXs or PCATXs this facility is available at low cost but on the proprietary common control exchanges now coming into service it is more complex, and therefore relatively costly. A special test register may be needed which can be assessed by a discrete input circuit. This register accepts unique digits corresponding to the individual circuit chosen – this information programs the coder. The routing digits are accepted by the translator as a normal routing (even though it is not) and the translator provides a translation which marks the coder from the marker. This marking is then extended to a particular secondary switch level for the selected outgoing circuit, and the call proceeds as normal; all subsequent numerical information is passed forward.

Testing using this facility can be made to test numbers, or to operators, on a peripheral PABX; but answering relay sets may be provided at tandems and sub-tandems to return either a single tone, NU interrupted with inverted ringing cadence, or a controlled level 800 Hz for automatic transmission testing. With this in-built facility automatic test-call sending, including transmission level checks, can be made from a co-sited PABX to a tandem – or remotely if this proves to be both necessary and economic.

Fault reporting and fault location

Since private switched networks are small versions of the STD network they pose similar maintenance problems. For each of the larger networks it is proposed to set up a private network co-ordinating centre (PNCC). Faults that cannot be located to an originating PBX can exist anywhere in the network and the PNCC will use reference centre techniques to pin-point likely areas to which the PABX maintenance TO's attention should be drawn. Local repairs and failures of calls not entering the network, including reports of identified circuit faults and exchange isolations, will be handled under existing 151 procedures.

work, to provide the customer with day-to-day knowledge about the network, and to pursue any difficulties throughout the PO maintenance organisation.

Sv5.3.2 (01-432 1382)

Crossbar exchanges
some further aspects of maintenance

This final part of an investigation into crossbar exchange maintenance examines major service failures, safety hazards and design weaknesses of the TXK3/4.

Safety hazard

All TXK systems have a good basic physical design so far as safety is concerned. In the TXK1 system the catch on the inter-rack doors caused concern as some doors do not always latch shut properly and swing open. It has also been found that high voltage supplies to some equipment racks have not always been labelled to the high standards we expect – this is being rectified.

One problem with hinged side panels in TXK3/4 was foreseen – they are no longer provided. Restricted parking for frame covers and the handling and storage of the bay upright covers are difficulties that still have to be solved.

Printout analysis

At present fault printouts on some systems may have to be analysed visually; this approach is not sufficiently effective so it is THQ policy to provide computer aided analysis facilities as soon as possible. This will be backed up by information about diagnostic routines which should aid maintenance men to locate faults.

TXK1 local. Computer-aided analysis and diagnostic routines have been available for these exchanges since 1971. Some seventy exchanges are now using the facility.

TXK1 GSCs. The computer program is at present being written and should be available for field trial by mid-1974; by then we should have completed the diagnostic information.

TXK1 SSC. Daily computer analysis and diagnostic information is available for the early units. In view of the size of SSCs, they will have on-line processing facilities by late 1974.

TXK3. Computer aided analysis is not yet available for this system but it is our intention to give this facility as soon as possible.

TXK4. The computer program has been written but will not be introduced for national use until its field trial has been completed.

Service meters

These meters will in the future have a major effect on the maintenance of common control systems. They will enable maintenance staff to see trends in traffic flow, faulty connections, seizures of common equipment and in TXK1 how many second attempt calls are failing. In this way it will be possible to direct maintenance effort more efficiently.

The trouble in all the TXK systems, except perhaps TXK4, is that although access points are available for meters from all common equipment, some of the meters have not been provided by the contractor. Information therefore can only be gathered from certain sections of the exchange at any one time and because the meters are not of the resettable type the work involved to get useful information is quite considerable. Arrangements are in hand to improve the provision of these service meters and if possible to introduce the resettable type.

Studies of in-service experience have still to be carried out before Service Department can advise Areas which meters to observe, how often, and what conclusions should be drawn from the results.

Maintenance notes

Because of the general lack of experience within the PO, SvD set up a system of maintenance notes enabling information about common TXK exchange faults, suspect equipment and faulting techniques to be sent to THQ for vetting and redistribution to all other relevant TXK exchanges. This has proved to be a most useful aid to maintenance and it is our intention to carry on using this method for the interchange of information. Perhaps we could remind TXK maintenance staff that we rely on you to let us know about any solutions to maintenance problems which you have found locally.

Major service failures

Common control systems, unlike Strowger, do have a weakness in that a simple fault can isolate large important parts of an exchange. Faults of this type can often be dealt with so that although the fault is still on, service can be maintained while faulting takes place. The reasons for isolations and the techniques employed to clear them have had to be learnt, with more experience being gained all the time.

The reasons for these isolations are being found and where possible circuits redesigned or working practices changed to overcome or reduce them. The out of service time is decreasing as maintenance staff become more experienced.

Acceptance testing

As TXK exchanges were brought into the PO network new acceptance testing techniques were introduced. Under Strowger practice, all items of equipment have a mechanical and electrical test by PO staff; but for crossbar the responsibility for the majority of these checks rests with the contractor, with the Clerk of Works satisfying himself that they have been done. More importance is being placed on the overall functional performance of the equipment. This is done by having a 20 000 call 'Call through test' and if more than 50 failures are detected the whole exchange is rejected. These figures should ensure that any exchange we accept is in good working order.

In our experience those exchanges which pass the call through test at the second or third attempt are usually a maintenance liability. It has been found that when some new crossbar exchanges have opened the number of printouts has been quite high (first attempt failures). A large number of the faults found have been due to installation defects in wiring and equipment. Experience has shown that the more meticulously installed exchanges give a better in-service performance without the need for concentrated maintenance effort shortly after opening.

Sticking RE relays in TXK1

These have caused serious problems in exchanges produced by GEC. The RE relay is similar to a 3000-type without the keramot lifting pin and brass stud. Sticking relays were first noticed coincident with the introduction of a new type of shelf cover (a cost-reduced version), and the manufacturer identified the cause of the sticking as the material used in the shelf cover sealing strip. By the time this article is published we hope the problem will have been satisfactorily resolved.

TXK1 equipment practice

Typical problems are difficulty in gaining access to the top shelf, damage to shelf wiring and bad positioning of ratchet and high speed relays. Some of these are due to PO policy changing the original system – for example, use of cable grid in place of oversuite trunking. Discussions with the manufacturers are taking place to overcome these difficulties. The methods of running and fixing wiring forms and the insulation used have been greatly improved and further improvements are being investigated. However due to the type of construction these forms will probably always be a source of faults.

TXK3/4 design weaknesses

Because the system was modified for the BPO network without full-scale laboratory tests, many problems have been found to exist. These arise from circuit design errors, inadequately rated components, inadequate circuit factors of safety and insufficient use of quenching techniques. Every known problem has now been referred to the manufacturer for action. Solutions for many of the problems have been approved and works specifications will be issued shortly.

Conclusions

Our aim has been to highlight the known weaknesses of existing crossbar systems and to emphasise that we need your continued co-operation in eliminating remaining shortcomings so that we can get the best possible out of each of the systems.

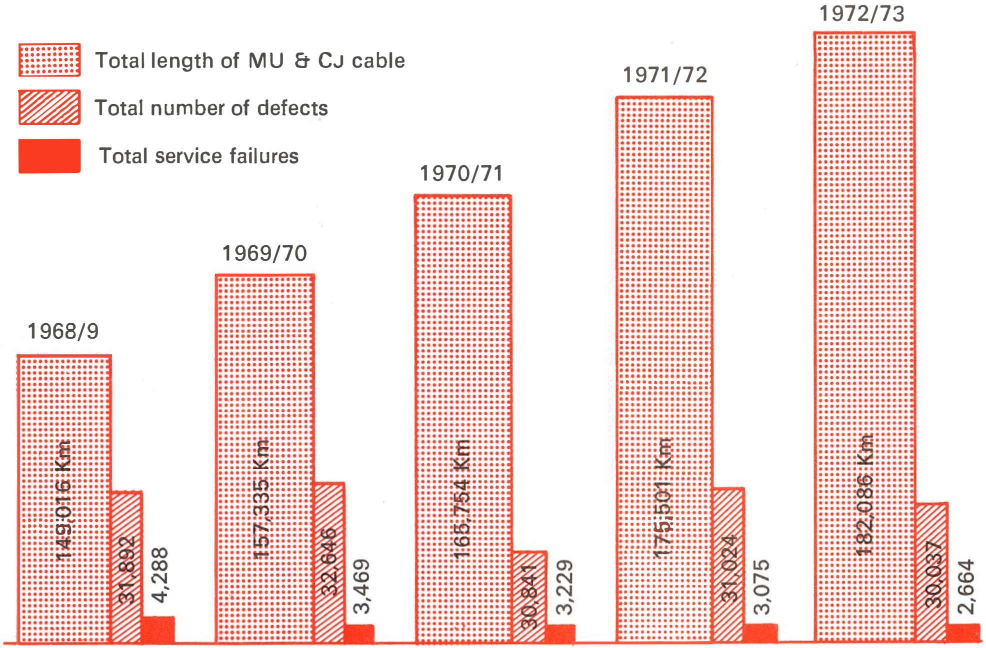
Those of you working with crossbar are well aware of its many good points but we are sure a brief recap of main features would not be out of place. These are:

- increased reliability of equipment when compared with TXS;
- in-built self checking facilities;
- system fault tolerance;
- automatic repeat attempt at call set up;
- by-passing of faulty paths and equipment;
- replication of controls;
- fault detection devices;
- automatic printout of faults and congestion failures;
- virtual elimination of regular routine maintenance tasks;
- computer assistance for fault printout in the switch block area.

Collectively our objective should be to provide customers with an acceptable quality of service as economically as possible. We feel that TXK systems have the potential to achieve this.

Sv6.1.1 (01-432 1391)

Trunk and junction cable maintenance



Cable represents a large capital investment in plant and a considerable PO asset in the number and variety of revenue-earning services it carries, and can potentially carry, as cable technology develops. The effective and efficient maintenance of cable systems, which include cable and associated transmission elements such as loading coils, repeaters and regenerators is, therefore, of vital importance to PO services and our customers.

This brief article is concerned with the cable aspect alone, and for those who may not be familiar with the abbreviations, MU stands for Main Underground, that is high frequency cables carrying the longer distance circuits between towns and cities, and CJ for Junction Cable, mainly audio type cable carrying shorter distance circuits.

Cable maintenance statistics are expressed in terms of sheath length regardless of size or circuit carrying capacity. The sheath length of the combined CJ and MU cable networks has now reached 182 000 kilometres, with a growth of 20 per cent in the past five years. This represents a distance of about four and a half times round the world.

The cables making up this total are a very mixed bag ranging from simple pair type cable veterans laid in the 1920s to sophisticated modern multi-coaxial pair types with potential circuit capacities of 100 000 plus. The types of cables also reflect the many changes which have taken place over the years in design and make-up: the earlier types have mostly lead sheaths and air/paper insulation; later types use plastic sheathing with aluminium foil moisture barriers; and the more recent coaxial cables have plastic anti-corrosion anti-abrasive outer covering on lead sheaths.

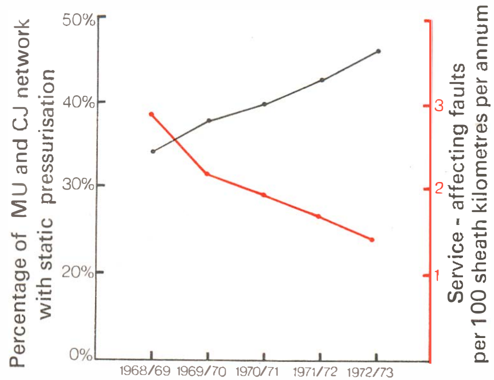
Various hazards and defects affect cables such as damage or displacement by roadworks – even, regrettably, by PO operations mostly beyond the direct control of cable maintenance staff. Some of these things affect service immediately; other defects, if attended to in time, can be prevented from causing service failures.

It is in the prompt and effective location and repair of service-affecting faults and in locating defects and preventing them from affecting service that the maintenance man comes into his own. In 1972/3 only 2664 or 8·9 per cent of all MU and CJ cable defects affected service. The equivalent figure nine years ago was 16.7 per cent. A service-affecting fault is one in which one or more circuits in a cable has its service affected. This can range from one faulty junction circuit in a small audio cable to 16 000 or more faulty trunk circuits in a multi-pair coaxial cable.

Over the past nine years the total number of defects of all kinds has hovered round the 31 000 a year mark. With the growth of the network during this period, this has resulted in a reduction of the defects per 100 km per annum from 22·03 to 16·5. The defects are classified in various categories – cracked sheath, failed sheath joints and so on. The relationship between the length of the cable network, the total number of defects and the number of defects affecting service over the past five years is shown in figure 1.

The improving service-affecting fault rate, particularly in respect of air-spaced cables which includes all coaxial cables, is largely due to pressurisation. It is some years, for example, since communications between exchanges and towns have been seriously affected by floods. Figure 2 illustrates how the rate improves with the improvement in pressurisation. It is rather chastening to reflect though, that so far less than half of the trunk and junction network is protected by static air pressure.

A brief explanation for the uninitiated: cables dependent on air spaces for their transmission performance can be kept free of the ingress of moisture and water by filling them with dry air under pressure. If all leaks and cracks in the sheath are located and sealed at installation, or subsequently for existing cables, the cable can be put under an air pressure which is static. When all leaks are not sealed the air pressure system is not static and continually leaks; this requires a continuous and controlled injection of air from a compressed air source. Such a pressure system is known as a flow system and is used in the local exchange network. Improving pressurisation will pay big dividends in the quality of service we can offer customers. In addition once having reached a static state, cables can be maintained with less trouble – no



more 'milk rounds' with compressed air bottles.

Despite the growth in system size the CJ and MU cable network is now being maintained by the expenditure of $2\frac{3}{4}$ million manhours a year as compared with $3\frac{1}{2}$ million manhours five years ago. It is just as well there has been this improvement, as the cost of MU and CJ maintenance has increased over this same period by nearly half. If 1962/63 monetary levels still obtained, however, our present costs would be a quarter below those of five years ago.

Two thirds of the annual 31 000 defects, nearly 21 000, are at underground chambers, footway boxes and jointing points. Long length cabling reduces the number of joints needed and helps in reducing the jointing point maintenance burden. Similarly, the prospective introduction of injection welding and other improved techniques for joint closing on new polyethylene sheath cables should reduce the problems with epoxy putty joint closures. The effect of these innovations will have little impact on the existing network for some time however. The most effective contribution a maintenance man can make to reducing defects is to take care when dealing with cable plant and see that cables are adequately supported and protected (both mechanically and pneumatically) at jointing points.

One major source of service-affecting faults (8.9 per cent of defects) is damage by outside non-PO agencies, or self inflicted by PO staff or contractors. The amount of damage caused by our own and our contractors' staffs is gradually being reduced by the continuing vigilance and care of those responsible, but damage by outsiders although reduced continues at a depressing 1300 cases each year. The new Plant Protection Officers scheme should help in this respect and no opportunity should be missed in publicising plant protection facilities such as the Freefone One Double One service to the EPMC. A word of caution however in this respect – if you do advise anyone about to excavate about the existence of PO underground plant, do be sure to give full and accurate information; otherwise you may make things very difficult for our legal colleagues if there is subsequent damage.

Another main cause of service-affecting faults is due to the older forms of coaxial cable pair soldered joints parting under tension. This rarely occurs with the more modern jointing techniques of brazing, now used both for provision of new coaxial cables and maintenance repairs.

The overall picture of MU and CJ maintenance is encouraging. A growing network is being maintained more efficiently and with fewer service-affecting faults than before. If we keep up the good work we can continue to improve our image by providing the sort of service our customers expect.

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FNFs matter

or the ones that get away

To say that the most expensive faults are those we don't find may seem paradoxical, but it is true none the less. Every working day many thousands of man-hours are spent dealing with fault reports or fault symptoms which subsequently go clear before the cause is discovered, perhaps only to reappear later and with the same end result. Whether or not these elusive fault conditions cause lost calls to the customer, and to what extent, we often don't know; but at the very least we can say they interfere with the smooth running of the maintenance service and have a nuisance value out of proportion to their numbers. Therefore any measures we can take to reduce the incidence of Fault Not Found clears (FNFs) will improve our overall effectiveness as a maintenance organisation.

FNFs are by no means a new problem and are encountered in all fields of maintenance. This short article is confined to Strowger exchange maintenance where the size of the problem has increased greatly with the introduction of night routing procedures. Indeed, it is not uncommon for between 60 and 70 per cent of all 'effective' fault recorder produced dockets (those resulting in a fault being cleared plus those classified FNF) to be in the FNF category; most of these cases arise from equipment shown faulty by tests at night but OK when retested the following morning.

Causes of FNFs

Many attempts to find and analyse the causes of FNFs have been made in the past with variable success – it is said that there are as many potential causes of FNF in a selector as there are component parts! Be that as it may, one thing is certain and that is that a very high proportion are due to false fault indications in the first place. If the routiner equipment has an intermittent fault, or is otherwise applying incorrect test conditions to a selector which cannot be expected to respond normally to those conditions, little wonder an FNF results some time later.

Some of the more common factors that affect routiners and cause spurious test failure indications are:

(a) access selectors – dirty bank contacts;

(b) pulse machines – speed variation;

(c) test unit relays – residual core magnetism or out of adjustment;

(d) test leads to equipment racks – higher resistance than the permitted maximum.

Of these, regular and frequent maintenance checks (see TI E6 R5011) should eliminate FNFs caused by access selector banks and test unit relay adjustments. Speed variation of pulse machines is never easy to diagnose, and still more difficult to correct, but a new transistorised speed governor of high reliability for pulsing machines no 14A is at an advanced stage of development and will soon be available as a replacement unit. Residual core magnetism in test unit relays and high test lead resistance are best diagnosed from the pattern of test failures, by analysing FNFs to see whether particular tests predominate when compared with results from the same type of routiner elsewhere, or whether they occur more regularly on certain remote equipment racks.

It is well known that group selector routiner 1st and 2nd Test Line Seized tests fail regularly and result in FNFs with equal regularity, particularly routiners AT 4514 and AT 4130. Works specification SV 364 shows how to eliminate the trouble by fitting a transistorised test line control circuit which is now available as a wired-up unit, AT 61323.

Automatic retesting

Much of the morning retest time is ineffective in the sense that a large proportion of the tests do not confirm overnight test results – hence we have FNFs. The automatic retest facility, available as a modification to 2000-type group selector and final selector routiners, (Works specification SV 348) eliminates much of this abortive work by causing the routiner to reset and immediately retest equipment failing a test at night. Then if the retest is OK, a docket is printed with the letters 'FNF' in place of the usual fault symptom number; but if the retest fails a docket is printed in the normal way. There is no need to make morning retests on equipment shown by the dockets to have been FNF during the night, only the necessity to record the fact on the fault history cards and to include the events in the total FNFs for that night on the night routing docket yield form A6224. In this way the morning retest work load can be reduced by up to a half.

Treatment of FNFs

All equipment passing a retest, either manual or automatic, is classified FNF and should be recorded on the fault history cards. In this way particular selectors having a history of FNFs will be exposed and these should be investigated. Assuming that the routiner is eliminated as a cause of spurious test results, the most likely reason for variations in selector/relay-set circuit response to test conditions is a component drifting towards the limit of acceptable adjustment, for example, a relay spring-set verging on the 'test' limit of tension. The Routiner Handbook should help decide which circuit elements are involved in particular tests that results in FNF clears. The pattern of FNFs shown by A6224 forms gives useful clues as to whether the routiner should be suspected of producing spurious results. A deterioration in the FNF yield over a period of time and an inferior comparison with the yield of other, similar, routiners are signs that the routiner may well be due for overhaul.

The control, and where possible prevention, of plant conditions that result in FNFs is of great importance if we are to continue the trends in better service to customers and in reduced maintenance costs. In any complex system and particularly in an electro-mechanical system such as Strowger, FNFs are bound to occur; and although not necessarily service-affecting, they should be taken as an indication that something is on the blink somewhere. Immediate action to discover the cause is seldom necessary but it can be a frustrating and expensive exercise; due regard to the history, patterns and trends of FNFs is a more fruitful line of approach. So if there are any golden rules to observe they might run thus:

1 Has the selector/relay-set a *history* of FNFs? If so, investigate the item.

2 Does analysis of the routiner fault test numbers show a *pattern* of FNFs? If so, look at the routiner.

3 Is the *trend* in the level of FNFs rising? If so, suspect the routiner.

The RANCH system of recording fault history (see *MN* issue 1) now on trial at the Manchester South and Guildford Areas will enable these questions to be answered more readily than the present system allows. In a future issue we hope to show the degree of success the trial Areas have met using RANCH to control FNFs.

It is, of course, impossible in a short article to cover every aspect of this subject and no attempt has been made to itemise circuit elements and components that are excessively prone to FNF clears. Perhaps this can be done at a later date. In any event we would welcome concrete evidence on ways and means to reduce the problem. And remember – FNFs Matter!

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Send your contributions to . . .

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