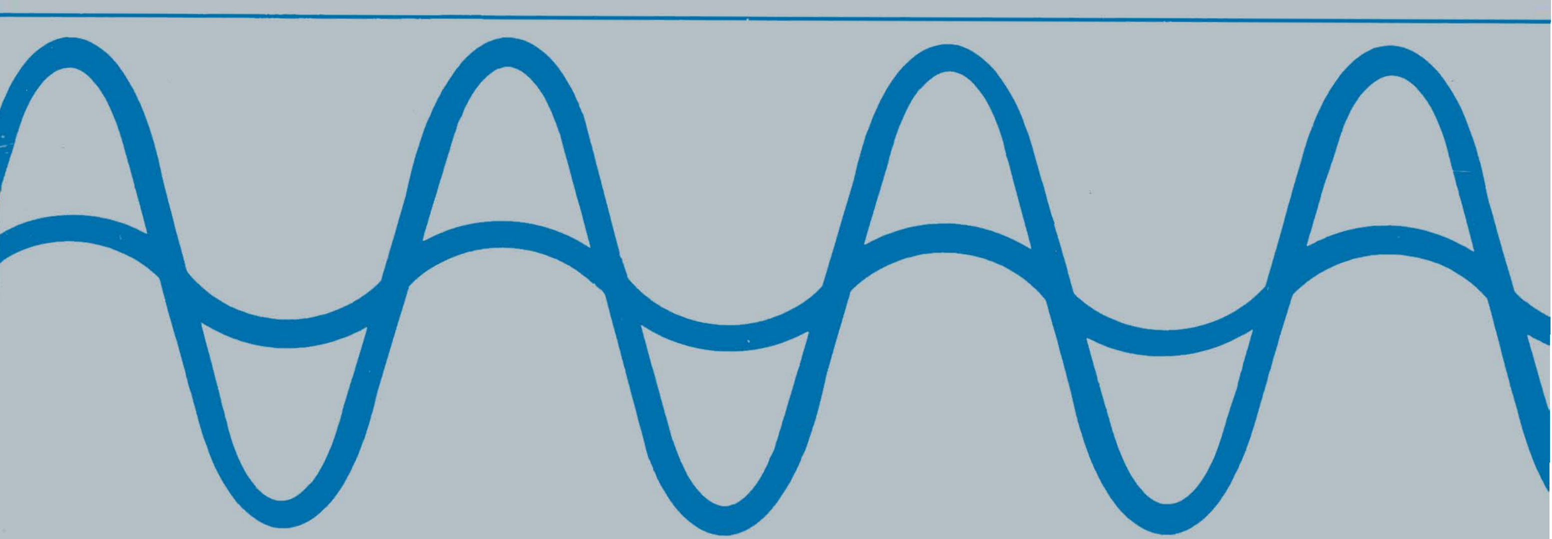
OPTICAL FIBRE SYSTEMS IN THE POST OFFICE TELECOMMUNICATIONS NETWORK



OPTICAL FIBRE SYSTEMS IN THE POST OFFICE TELECOMMUNICATIONS NETWORK

Introduction

This booklet gives a brief background to the purchase of the proprietory optical fibre line systems together with some basic information about the routes and technical features.

The booklet is published for general information purposes and the information contained herein has, in the main, already been made public in press releases etc.

Background information

Throughout the history of radio and carrier telephony on cables there has been a continuing trend to the use of higher frequencies. This is primarily because it is generally more economic to obtain additional capacity by exploiting the higher frequencies than to have a number of co-routed lower capacity systems. With the invention of the laser in 1960, it was natural that the possibility of communicating at light frequencies should be investigated.

Initially the possibility of transmitting light energy through the atmosphere was looked at. Unfortunately as the frequency of electro-magnetic signals is increased they become severely attenuated by such conditions as fog, rain and snow. This idea was not therefore considered to be feasible for the majority of terrestrial applications, although optical communication in space is already becoming a practical proposition. As far as earthbound systems were concerned the next logical step was the study of suitably guided light signals since a light waveguide would protect the light beam from atmospheric disturbances.

Early attempts at light guidance over long distances employed lenses enclosed in a suitable tube so that any tendency of light to spread apart by diffraction could be counteracted and extraneous light and moisture could be kept out. Curved mirrors were used to guide the light beam around bends. Systems such as these have not come to fruition to date and are not likely to in the foreseeable future because the problems of alignment and positioning of the lenses would have been such that they would not have been economically viable.

The illustrations show early designs of optical fibre cable, not necessarily those to be used in the Proprietary Optical Line Systems which are the principal subject of this booklet.

Illustrations are not to scale

It has been known for a long time that light can be guided in thin fibres made of transparent dielectric materials. The concept of using glass fibres as a transmission medium was suggested in a paper published in 1966 by Kao and Hockham of Standard Telephone Laboratories (UK) (STL).

The British Post Office (BPO) became interested in the possibilities of optical fibre transmission at about this time and, in conjunction with STL, the most important parameters for an optical fibre transmission system were soon defined. Interest originally centred on fibres capable of sustaining high data rates (eg 100 Mbit/s or greater) in a digital binary transmission system with a laser source. Fibre losses of less than 20 dB/km were considered necessary for an economic system to emerge and the sources of loss in the appropriate glass materials were identified by the BPO Research Department in collaboration with Sheffield University. The basic requirements were determined during 1966-67 and work commenced to seek solutions to the many problems which had been identified. A major advance came with the announcement in 1970 by Corning Glass Works (USA) of the first 20 dB/km loss optical fibre. It thus became clear that the original targets set some years earlier were indeed feasible and world wide R&D activity into all aspects of optical fibre systems grew rapidly.

Since then major advances have occurred in every area of the technology to the point where many varieties of system have now been developed and installed in realistic and practical environments around the world.

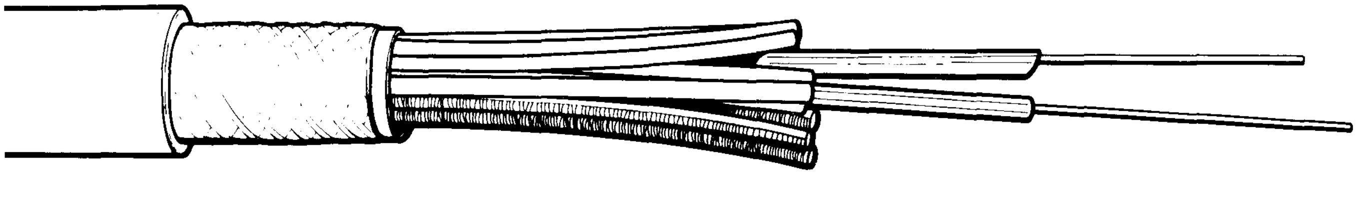
(a) PO Research Department cable with Double Crucible fibre.

(b) TCL Single Cavity cable with GEC fibre.

(c) BICC "PSP" cable with Corning fibre.

(d) STC cable.

(a)



Advantages of optical fibre systems

Optical fibre systems have enormous advantages over existing transmission systems such as:

i. Very large information bandwidth and therefore a potentially high transmission capacity.

ii. Potentially low material cost.

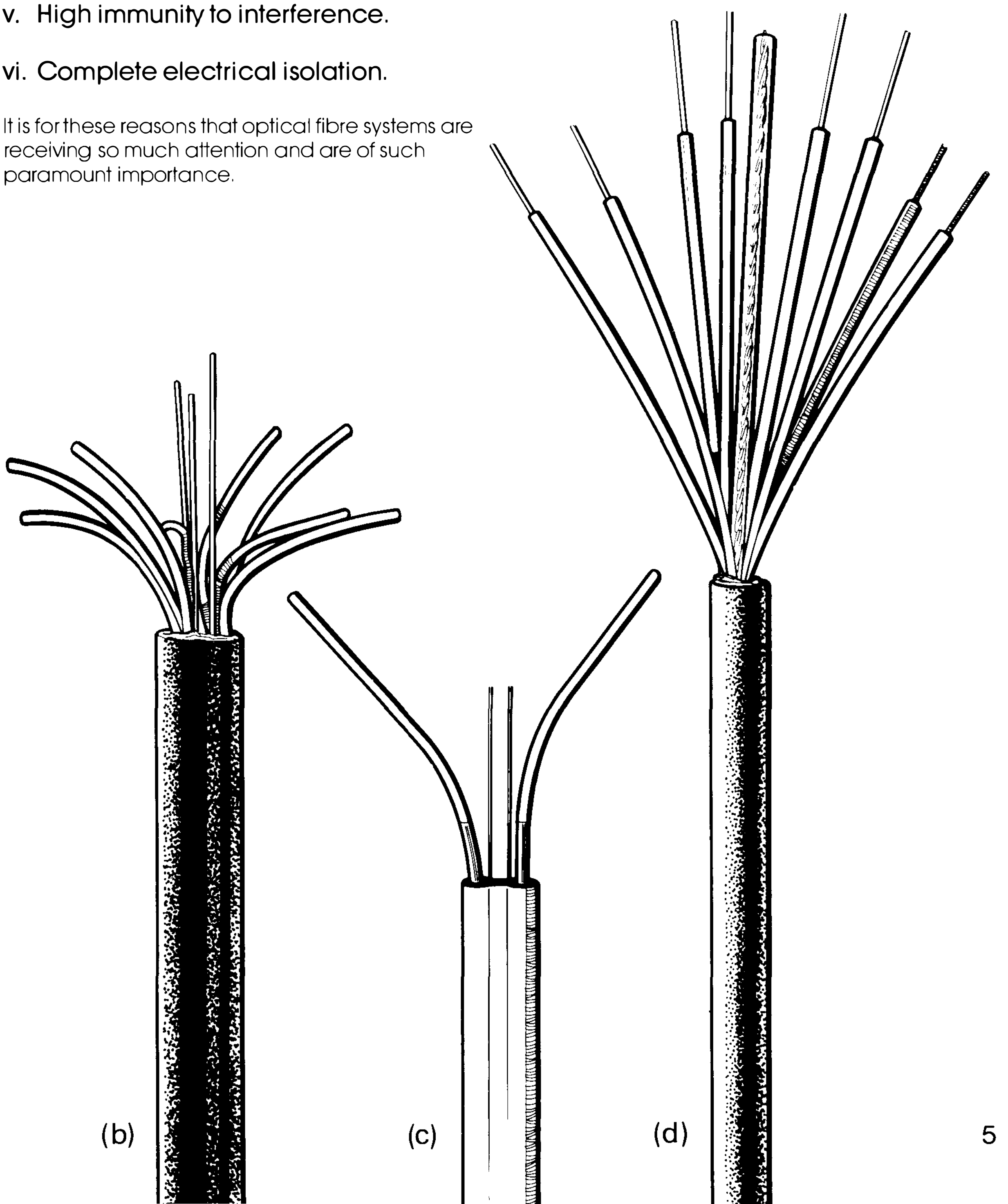
iii. Small cable size leading to low duct occupancy.

iv. Negligible crosstalk.

v. High immunity to interference.

vi. Complete electrical isolation.

It is for these reasons that optical fibre systems are receiving so much attention and are of such paramount importance.



(b) (c) (d)

The BPO proprietary optical fibre systems

By the end of 1977 several of the major British equipment manufacturers had demonstrated optical fibre systems in working situations, and the British Post Office had also developed its own systems operating at 8 and 140 Mbit/s. Details of the various systems are given in Appendix 1.

It was clear that the time was now ripe to follow up this work by ordering production systems so that industry on the one hand could gain further experience in the manufacture and installation both of the cable and equipment and the British Post Office on the other, to gain operational experience of this new transmission medium. To this end the Post Office has now placed orders for a total of 34 systems on 15 different routes located throughout the UK. Details are given in Appendix 2. The systems are essentially proprietary ones, designed to meet the needs of both the Post Office network and of export customers. The systems will be a spur to British activity in this important field and not only provide much needed additional capacity for the Post Office network but also enable British industry to demonstrate their products and capabilities in this rapidly evolving field of activity. In the main, the provisioning of the systems is being carried out using the normal procedures applicable to conventional PO line transmission systems. One notable exception is that, because there is not yet enough experience to be confident about specifying separately the requirements of optical fibres and their associated equipments, a turnkey contract approach has been adopted whereby a prime contractor is responsible for the total provision of all the cable and equipment on each route. Post Office specifications, setting out the initial PO proposals for optical fibre systems were issued as a basis for the tenders. However, because of the proprietary nature of the systems being ordered only essential features eg safety and overall performance, have been made mandatory.

Orders have been awarded to STC, GEC and Plessey for the supply and installation of optical fibre line transmission systems - cables plus equipment - for the expansion of the UK telecommunications network. Further orders will be placed for digital multiplex equipment to operate in association with them.

The various systems ordered operate at 8, 34 and 140 Mbit/s, equivalent to 120, 480 and 1920 telephone channels respectively, and will form part of the evolving digital network being developed by the Post Office leading to the Integrated Services Digital Network in conjunction with System X exchanges.

The 140 Mbit/s systems, six of which have been ordered (on three routes) will be used in the trunk network. These systems will have a typical route length of 60 km and require dependent repeaters located at intervals of about 8 km. (Systems of similar capacity on coaxial cables require repeater spacings of 2 km.) The optical fibre systems will use semi-conductor lasers as the light sources.

The 34 Mbit/s systems, four of which have also been ordered for the trunk network (on two routes) are expected to be similar in design to the 140 Mbit/s systems except that their repeater spacings will be 10-11 km. 34 Mbit/s systems are expected to be especially suited to the needs of export markets.

8 Mbit/s systems are being ordered for both the trunk and junction networks. In the former, the route length for the two long-haul type systems is about 50 km whereas for the latter short-haul type systems the lengths are typically between 10 and 20 km. 24 short-haul junction 8 Mbit/s systems (on nine routes) form the largest group of systems to be ordered. Because they are shorter in length and usually located in urban areas, only a few of the systems have intermediate repeaters. When intermediate repeaters are required they are usually housed in intermediate surface buildings. Repeater spacings can be up to 12 km.

Various cable designs are to be employed and although about 480 km will be of the underground type, there will be some 46 km which will be aerial cable (cable suspended between poles) and a smaller length which will be sub-aqueous. The optical fibres to be used in the cables are mainly of the graded index type, and low loss fibres (less than 3 dB/km at the wavelength of operation, typically 820/900 nm) will be used on the longer systems where there is economic advantage in so doing. To demonstrate the practicability of optical fibres produced by the double crucible process, a process pioneered by the Post Office Research Department, it is planned to use such fibre on one or two suitable routes.

The exercise is a bold step into a new technology which the British Post Office is confident will be a great success. The first systems will be ready for service by about September 1980 and the remainder will follow within a year or two. The data and operational experience gained from the exercise will form a basis for the standard production systems of the future.

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Further information

Further information may be obtained from:

British Post Office Telecommunications
Headquarters
Network Executive
Transmission Department NE/T1.1.1
Room 608
2-12 Gresham Street
LONDON
EC2V 7AG
Tel: 01-357 3448

Appendix 1

Experimental and Demonstration Optical Fibre Systems in the UK

	Bit Rate Mbit/s	Date of Installation	Route Length km
British Post Office BPO			
Martlesham-Kesgrave	140	1977	6
Martlesham-Ipswich	8	1977	13
York-Haxby	2	1980	5.5
Gloucester-Walham	2	1980	3
Standard Telephones and Cables Ltd STC			
Hitchin-Stevenage	140	1977	9
GEC Telecommunications Ltd GEC			
Uxbridge-Ruislip	8	1979	6
Plessey Telecommunications Ltd PTL			
Maidenhead-Slough	8	1979	14

Appendix 2

Proprietary Optical Fibre Systems in the UK

System	Prime Contractor	Route	No. of Systems	Network Application	Ready for Service	Power Feeding	Route Length km
140 Mbit/s							
	STC	London-Basildon	2	T	1982	√	47
		Basildon-Colchester	2	T	1982	√	61
	GEC	London-Reading	2	T	1980	√	74
34 Mbit/s							
	GEC	Oxford-Reading	2	T	1981	√	48
	PTL	Guildford-Reading	2	T	1982	√	53
8 Mbit/s Long Haul							
	GEC	Banbury-Oxford	2	T	1981	√	39
8 Mbit/s Short Haul							
	STC	Aberystwyth-Ponterwyd	2	J	1981	X	20(A)
		Aberdeen-Kingswells	2	J	1981	X	12
		Croydon-Vauxhall	2	J	1980	X	15
		London-Vauxhall	2	J	1981	X	4
	PTL	Corris-Dolgellau	4	J	1981	√	16(A)
		Corris-Towyn	2	J	1981	X	23(A)
		Corris-Machynlleth	4	J	1981	X	9(A)
		Brownhills-Walsall	2	J	1980	X	9
	GEC	Arrington-Cambridge	2	J	1981	√	17
		Total	34				447

T = Trunk network
J = Junction network
A = System with aerial cable sections

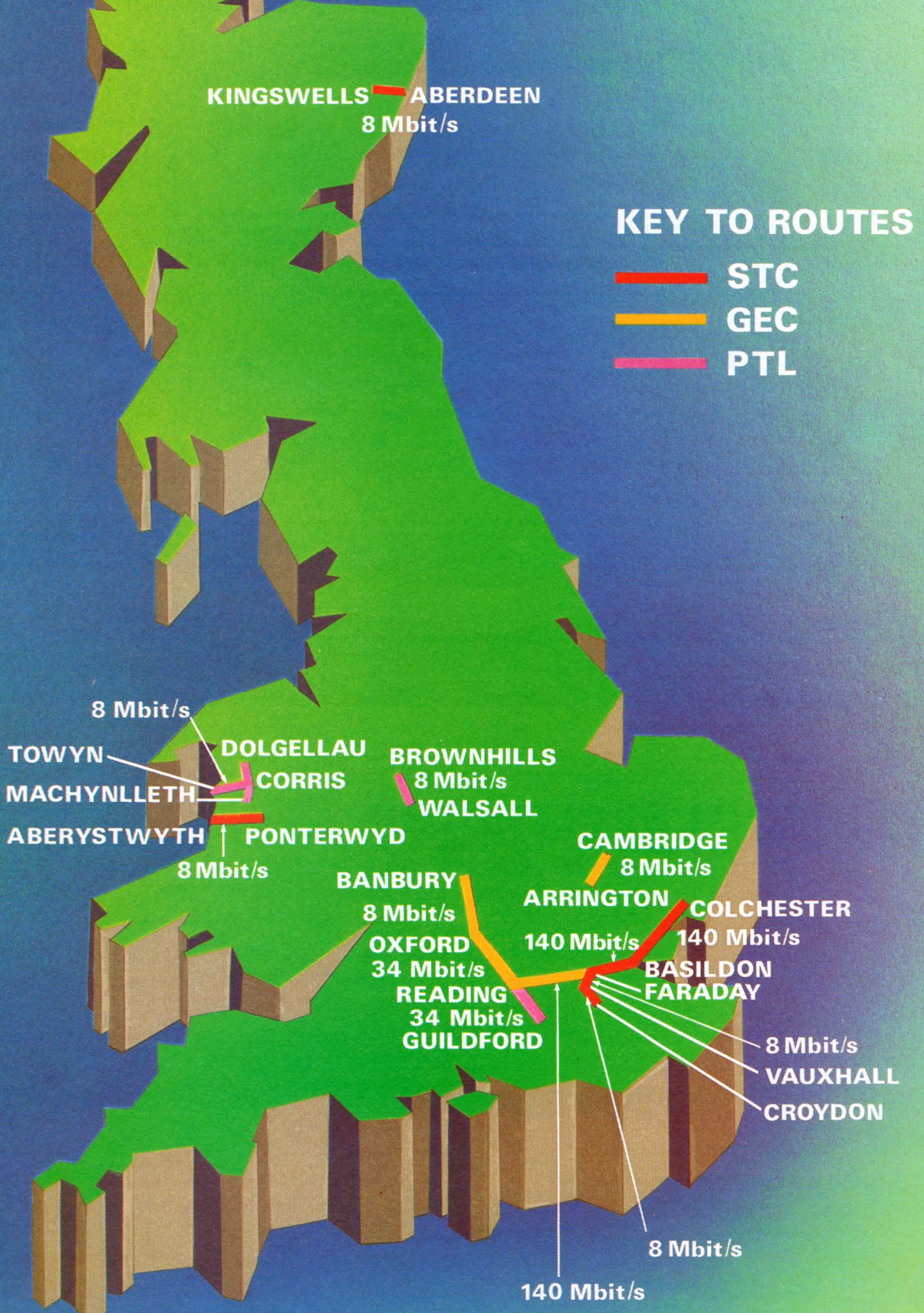
Appendix 3

Some Technical Details of the Proprietary Optical Fibre Systems

(See Appendix 2 for details of routes etc)

	8 Mbit/s Short-haul	8 Mbit/s Long-haul	34 Mbit/s	140 Mbit/s
BPO Specification	RC 8107	RC 8106	RC 8116	RC 8108
Network Application	Junction	Trunk	Trunk	Trunk
Typical Maximum System Length	c. 25 km	280 km	280 km	280 km
Repeater Spacing	up to 12 km	up to 12 km	up to 14 km	c. 8 km
Power Feed Station Spacing	Not applicable	up to 60 km	up to 50 km	up to 32 km
Equipment Practice	TEP 1	TEP 1	TEP 1	TEP 1
Operational Wavelength	← 850 or 900 nm →		850 or 1300 nm	850 nm
Opto-electronic components				
Transmit	LED or Laser	LED or Laser	LED or Laser	Laser
Receive	APD	APD	APD or PIN	APD
Cable				
No. of Fibres	8	8	8	8
Fibre Type	← Graded Index →			
Fibre Dimensions	← 50/125 μm →			
Optical Attenuation	up to 8 dB/km	← 2-8 dB/km →		3 dB/km
Power Feed Conductors	No	Yes	Yes	Yes
Supervisory System	Basic	← Comprehensive →		
Engineering Speaker	Not usually	Yes	Yes	Yes
Power Feed System	No	Yes	Yes	Yes

GEOGRAPHIC LOCATION OF PROPRIETARY OPTICAL FIBRE SYSTEMS



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