SCTE Service Technician's Course

Working for the Benefit of the Broadband Industry

Reference Manual

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Welcome to the SCTE™ Manual

This handbook is designed as a stand-alone reference manual for technicians working in the broadband telecommunications industry. It may be used either on its own or as an integral part of a classroom course including practical work to enable the student to progress to examination and certification.

We hope you and your career benefit greatly from this handbook and associated training course. Please consider joining the SCTE and taking advantage of the benefits that come from being part of the industry's foremost technical institution.

About the SCTE™

Founded in 1945, the SCTE is a non-profit making organisation, managed by an Executive Committee of elected volunteers, whose aim is to raise the standard of broadband engineering in the telecommunications industry. The Society particularly concerns itself with the training and career advancement of technical professionals in this field.

First introduced in 1994, the SCTE training courses have achieved wide acceptance as the standard for young technicians wishing to enter the field of cable telecommunications and for those wishing to advance their knowledge and career prospects. They are used in-house by a number of operating companies and SCTE engineers can be found working in a variety of international organisations.

As a Learned Society, SCTE is able to provide accreditation and certification for its members, giving them professional standing within the industry. Full Members and Fellows are allowed to use the designations MSCTE and FSCTE after their names whilst Technician Members may use TMSCTE. There are also categories for Student and Associate Members which carry the designations SMSCTE and AMSCTE respectively.

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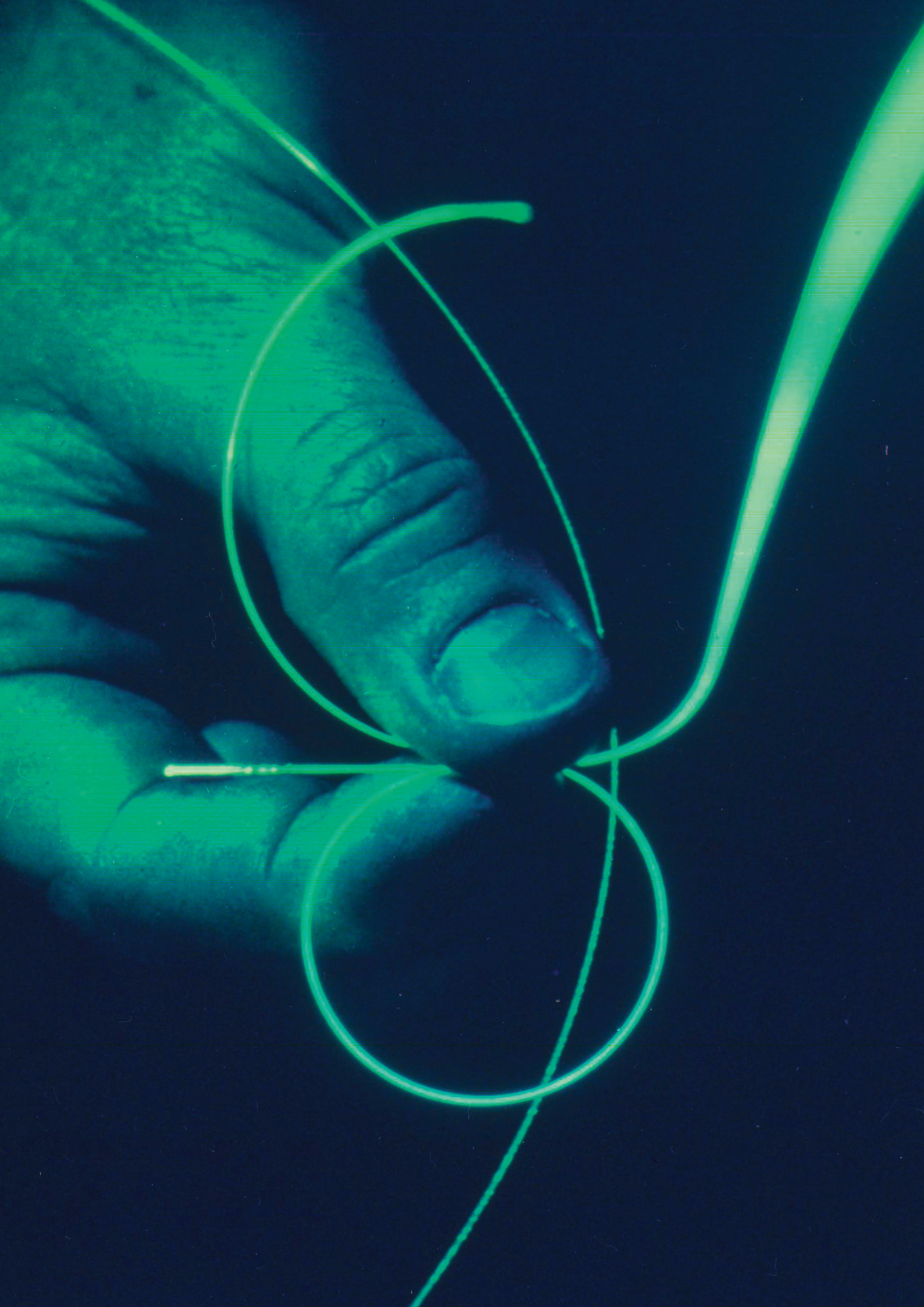

Section One

1.1 Introduction

A service technician is required to locate and fault find breakdowns, restore the service to the subscriber(s) and possibly aid an installation technician where trouble has been experienced in establishing an acceptable level of service. Service technicians are normally required to operate on the coaxial sections of the network, however, fibre optic technology is reaching more deeply into networks and ultimately will reach the subscribers' homes.

The service technician must possess all the skills of the installation technician in addition to those required for servicing and maintaining the RF network from the optical hub to the subscribers' premises. Successful completion of the SCTE Installer Course or an equivalent level of knowledge and experience and familiarity with the use of decibels should therefore be a requisite before embarking upon this Service Technician Course.

In companies that operate a 'baseband' telephony service on twisted pairs, operating alongside the coaxial network, a separate group of service technicians to maintain that service may be employed. One group will handle telephony faults; the other will handle coaxial network problems. The forward march of technology has made the possibility of "learning on the job" less feasible and a sound background knowledge of the technologies and techniques involved is an essential part of the modern service technician's portfolio. Such knowledge enables faster location and diagnosis of a fault and restoration of the service. The ability to tackle more obscure problems means a better service to subscribers, giving them a very favourable impression of the company. It is always a good idea to remember that, ultimately, it is the company's customers that pay the wages.

Past experience has shown that the majority of reported faults occur within the subscribers' homes and are either telephone-related or TV and interconnection problems. Set top boxes (where supplied) come a close third. The remainder of faults occur on the network outside dwellings and are closely monitored, restored properly and are normally out of the reach of the public.

1.1.1 Customer-Technician-Company Relationship

In a perfect world, the installation technician would be the only company representative to meet the customer. Unfortunately, this is not a perfect world and occasionally faults occur that require the attention of the service technician. In some well-supervised networks, the imminence of a fault is flagged-up by the network management system and remedial action can be taken before a total failure occurs.

Sometimes, and on networks without a satisfactory supervisory system, the customer reports a fault before the company is aware of it. The customer's home is frequently where a fault occurs; loose plugs and wrong connections, settings disturbed by cleaning or curious children rank highly in the list of causes. It is under these strained circumstances that the service engineer has to meet the subscriber and spend time with him or her to re-establish confidence. It must also be borne in mind that the service technician may be set a number of tasks to perform daily by his employer that may perhaps be in conflict with the need to restore good relations with the subscribers. Never forget that it is the customer, through his subscriptions, that eventually pays the wages of the service technician.

Although this kind of field work may require some careful balancing of the obligations placed upon the service technician, it is an interesting and varied occupation and a constant challenge in which no two days are alike.

1.2 Measurements

The everyday activities of a service technician will inevitably involve the need to make measurements on the network. Such measurements are frequently the indicators of the nature and cause of a fault. The following paragraphs summarise the types of measurements a service technician will have to make. The subject is covered in greater detail later in the course.

1.2.1 Voltage, Current and Resistance

On baseband telephone networks, the presence of the 50 volt line power can be checked using a digital multimeter (DMM). The DMM can also be used to check the presence of line power and the amplifier DC supply rail on a CATV amplifier. In the resistance measuring mode, the DMM can be used to check the loop resistance of telephone drop cables and the continuity of fuses, cables etc.

1.2.2 Signal Level

A signal level meter (SLM) is basically a calibrated receiver that can be tuned to any signal on the network and measure its voltage. It can be used at various points throughout the network, most significantly at the input and output test points of a CATV amplifier, at the subscriber multitap and in the subscriber's home. Test points are provided on amplifiers for non-intrusive measurement of signal levels. A suitable SLM will measure digital and analogue signals on both the downstream and return path (upstream) sections of the network.

1.2.3 Radiation (Leakage) and Ingress

It is vitally important that radiation from the network is kept to an absolute minimum so as to avoid interference with essential radio communications such as the emergency services and aircraft radio. Leakage from poorly-made connectors and loose-fitting amplifier covers can also affect viewers using their own antennas for terrestrial reception. Tracking such radiation can sometimes be done using a signal level meter of sufficient sensitivity, but is best and most efficiently achieved with dedicated 'sniffer' equipment.

Ingress of interference can occur at the same point as radiation and is more commonly found in the return path. Poorly-made connectors and damaged cable outer conductors account for most instances of ingress on the network. However, poor quality 'do-it-yourself' cable extensions in the subscriber's home are a frequent cause of intermittent interference.

1.2.4 Cable Fault Location

The RF Time Domain Reflectometer is a radar-like instrument that sends a measured pulse of RF down coaxial cable, and then "listens" for the reflected pulse from a damaged section of the cable. The time taken for the total journey is measured and converted to distance to give the user an accurate position of the fault. Both open and short-circuited cables give a good return signal, and other areas of damage such as moisture ingress or deforming of the cable's dimensions can be deduced from the trace obtained on the instrument's screen.

1.2.5 Telephony and CAT5e Cable

Diagnosis of a number of faults is possible using a dedicated telephony cable tester such as type SA9083; other instruments of a similar kind are also available. Some of the faults specific to multipair cables may be traced with these testers. Local Area Networks (LANs) using CAT5e cable can be checked readily with dedicated hand-held test instruments such as the “LanScaper” and the “Varitest”. Telephony faults at a basic level can be diagnosed simply by the presence or absence of the dial tone and by the ‘engaged’ tone.

1.2.6 Restoring the Service – Service Technicians

In order to restore normal service, the first step is to locate the fault and then repair the breakdown. This action may often become necessary if installation technicians encounter a fault during their operations and are unable to resolve the problem themselves. This applies to both CATV and telephony services.

1.3 Fault Finding on CATV

1.3.1 The Customer Service Department

When a fault occurs on a cable network, one or more customers connected to that service will experience a failure of operation and will complain. The complaint is directed to the customer service department of the cable company where, if the customer service operator asks intelligent questions, the task of the service technician can be considerably eased. Very often the first indication that a fault has arisen on a network is when a customer reports poor or no service. Furthermore, when numerous complaints arrive from a particular area, it is possible for the customer service operator to deduce the approximate location of the breakdown. Modest technical training of customer service staff is a good investment and is to be encouraged.

Questioning the nature of the fault and whether it affects all services, or selected ones such as TV, radio, data or telephony, also assists in determining the nature and possible location of the problem. Similarly, customer service operators should be able to prevent a service technician call-out e.g. for discharged remote control batteries, mis-tuned receivers, set top boxes not powered or fly-leads disconnected etc. by gaining the co-operation of the customer in examining his in-home equipment.

1.3.2 Assisting Installation Teams

Sometimes a new installation will not work. If a cursory examination by the installation team of the network termination equipment (TV set top box and cable modem) proves that it is working and the set top box, where fitted, has been initialised, the help of a service technician is requested.

The service technician will repeat the cursory tests made by the installers and, after confirming their findings, will proceed to a deeper investigation of the fault condition. A check at the wall socket using a signal level meter will determine whether signals are being delivered from the network. This will be followed by checking for the presence of any “by-pass” channels at the output of the set top box, and checking that the TV receiver is tuned to the output channel of the set top or to the video output of the set top box. Ensure that the set top box and, if supplied, the cable modem are powered. All these checks are simple to perform and help to quickly locate the problem.

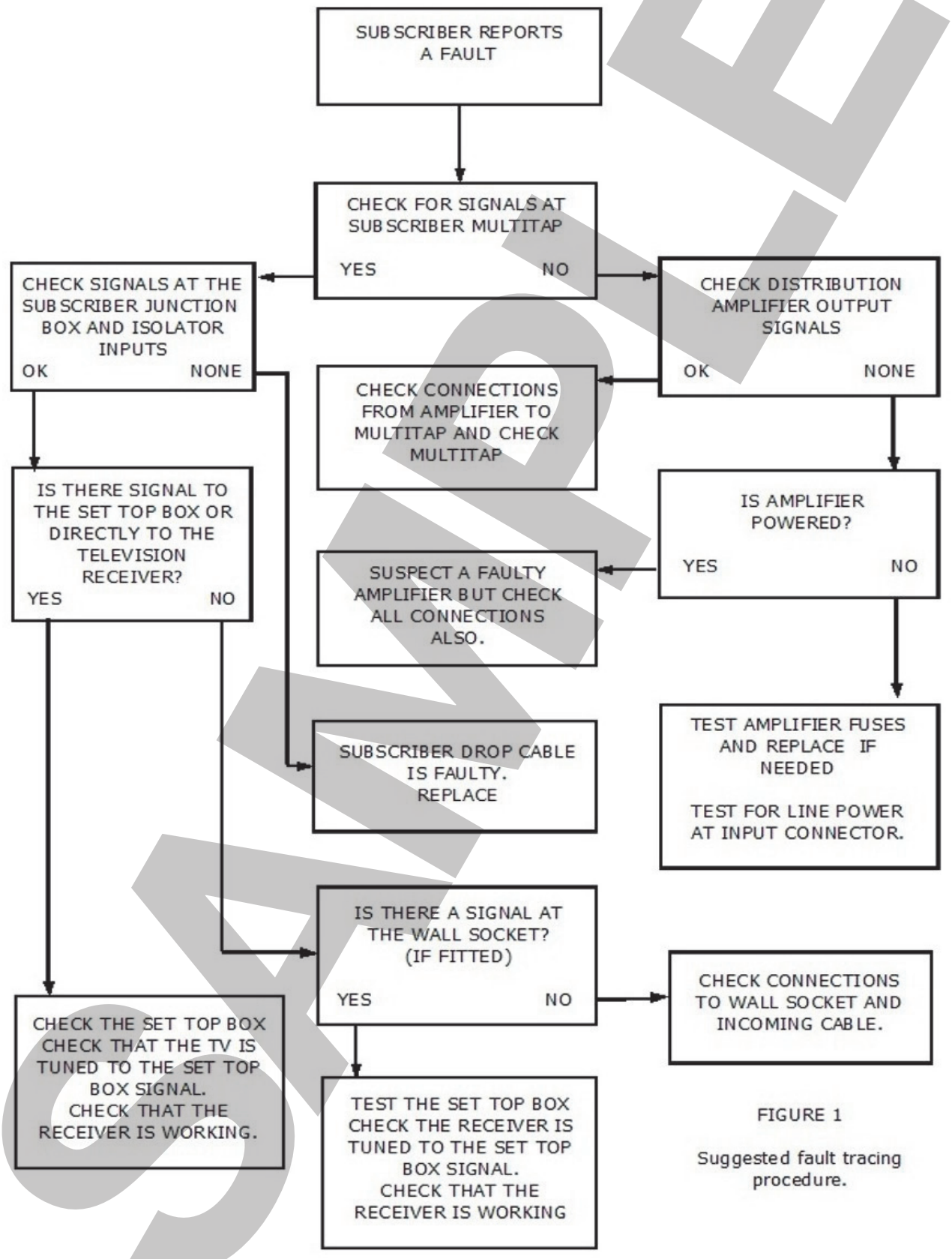

FIGURE 1

Suggested fault tracing procedure.

In the absence of signals from the network at the wall socket, the next point to check is at the subscriber tap. If signals are present there, the fault must be in the drop cable or any connectors along its length. Connectors are the easiest items to check first, working backwards from the house to the street cabinet. The latter procedure also applies to installations without a set top box. The fault finding should be logical and methodical.

If the fault is beyond the subscriber multitap it is likely that several other subscribers are affected. Faults beyond this point should be reported to a network technician and assistance offered in tracing and clearing it.

1.3.3 Responding to a Service Call from a Subscriber

A logical pace to commence a subscriber's complaint of poor or no service is at the subscriber's multitap connection in the street cabinet. If there is an unused output on the multitap, remove the termination and test for signal there. Failure to find a signal, or the presence of an impaired signal, invariably means that there is a fault on the distribution network and it should be reported to a network technician for investigation. Offer your help in tracing the cause.

If the signals are present at the subscriber's multitap output, the F-connector should be checked and re-fitted if necessary. The subscriber should be contacted and asked to check the service at his home to see if the fault has been remedied. However, if the fault persists, a visit to the subscriber is required and this should be conducted calmly and methodically with the utmost respect for - and courtesy to - the customer. Remember again that you are a representative of your company and the subscriber is your customer. The diagnostic flow chart of Figure 1 presents a logical guide to fault tracing.

1.4 Fault Finding on Telephony Services

It is necessary to firstly determine that the customer's telephone and his ancillary equipment (facsimile machine, answering machine etc.) are approved types and do not exceed the REN number permitted. Look for the REN (ringer equivalent number) on the customer's equipment. The normal maximum REN is 5 (i.e. the sum of all the RENs of the attached devices). Again, the customer services staff can be very helpful in locating the area of any fault simply from the addresses of complaining customers. On many telephony networks, a sophisticated network management system may be in operation and will have alerted company staff to the presence of a fault.

Telephony systems carry a DC line voltage of between -48 and -50 volts and a test for this is one of the first steps in ascertaining the nature of the fault. The dial tone must also be present before communication can proceed, and testing for this is made using the 'butt' set. A typical butt set, or lineman's handset integrates an earpiece, a mouthpiece, a dialling interface, and a set of test leads for connecting to the telephone circuit. Most handsets are designed to be used with analogue "POTS" lines, and have limited or no function with digital circuits.

If the line is dead, testing backwards to the street cabinet or distribution frame can be continued until the dial tone appears. As with the cable communications service, it may be useful to make a preliminary check with the butt set at the street cabinet before troubling the subscriber. If the fault can be rectified at that point, the subscriber should be called and informed that service has been restored.

Street cabinets and distribution frames have two sections: the 'E' (Exchange) side and the 'D' (Distribution) side. This is a convenient point at which to disconnect a subscriber line for testing.

If you hear an engaged tone when dialling the subscriber's number from another line, (with no dial tone at the master socket), this indicates that a short-circuit is present on the line. Disconnect the subscriber's line from the 'D' side of the frame. If dial tone is heard on the 'E' side connection block, the incoming line is clear and the subscriber's line is defective. If no dial tone is heard on the 'E' side, there is a fault on the incoming line or on the multiplexer that serves it.

Incorrect ringing or continuous ringing of one or more of the extensions is normally due to incorrect installation. Check the wiring of the master and extension sockets and transpose the incorrect wiring connections as necessary. If an extension does not ring, the 'ringer' wire may be broken or otherwise disconnected, or possibly the telephone itself may be faulty. Try a replacement telephone.

Crackling and intermittent service is usually traceable to a poor or loose connection. Ingress of water may also be a cause.

1.5 Repairs and Replacements

Before a repair on any piece of faulty equipment is attempted, it is imperative to check the arrangements for service that have been set up between the network operator and the equipment supply company. It is also essential to establish the level of repair capability of any in-house repair workshop. The warranty on relatively new equipment should also be checked and the conditions observed.

The two categories of repair activity are 'on-site' and 'workshop'. Each of these activities is broken down into three levels:

- Component level: undertaken on out-of-warranty equipment only and by technicians with special training and requisite qualifications. It should never be attempted on-site.
- Board level: appropriate where the equipment design is modular and removal and replacement of the complete equipment may be highly disruptive.
- Equipment: small items such as set top boxes and cable modems are easily replaceable because they are not fixtures. Replacement of these items is preferable as it causes less disruption in a subscriber's home. Fixtures such as amplifiers do not, generally, require total replacement unless the entire item is damaged physically. Modular internal construction allows defective sections to be quickly replaced.

1.5.1 On Site

It is not desirable to conduct on-site repairs in the customer's home except for small items such as fly-leads and power cables. Set top boxes and cable modems are more easily repaired in a workshop or by the manufacturer or importer. Besides the disruption caused by any attempt to repair down to component level, there are health and safety issues concerning the use of soldering irons and solder and exposed live circuitry.

Similarly, within the network, it is inadvisable to attempt component level repair except for defective connectors. There are health and safety considerations besides the difficulty of using test equipment and soldering irons.

Manufacturers of network equipment have taken into consideration the need to facilitate easy replacement of defective items, and have adopted modular construction. Short service downtimes are imperative to minimise customer dissatisfaction.

1.5.2 Workshop

Whilst some network operators provide workshops for the repair of defective modules and non-fixture equipment items, a more workable arrangement may exist with the equipment supplier under a maintenance contract. Component-level repairs generally require specialist technicians and test equipment to repair and re-calibrate the defective equipment.

1.5.3 Stock Faults

The term stock fault is applied to a fault from a well-known cause. If a stock fault situation is seen to be arising on a particular piece of equipment, it should be reported to the supplier to allow subsequent production of the item to be modified. If the fault involves a safety issue, the manufacturer may recall it for diagnosis, modification and the possible supply of a suitable modification kit for application in the workshop.

1.5.4 Warranties

Some manufacturers and importers impose restrictions on the opening and fault diagnosis of equipment supplied by them during a specified period after its purchase. Failure to observe these limitations may result in a refusal to repair the item at no charge under the terms of the warranty. Before attempting to open any equipment, it is advisable to check its warranty conditions.

1.5.5 Spares

Spare parts range from connectors and short fly-leads to whole equipment items like set top boxes and amplifier modules. Daily checks on the vehicle stock of spares should be carried out and any deficiencies remedied. All spares carried on the vehicle should be stored securely and should come complete with any ancillary items. Speedy and effective restoration of the service depends upon the condition of spare parts. Defective items must be returned to the workshops for despatch to the suppliers or repaired and returned to stock. Do not carry defective items on the vehicle in case of a mix-up!

1.6 Preventive Maintenance

The majority of cable network operators have installed a programme of preventive maintenance aimed at minimising service downtime and the consequent anger of subscribers. This programme operates alongside any network management system.

As good as network management systems are, the visual inspection and regular signal level policing of a network has many advantages and allows for instant, on-the-spot action to prevent service deterioration

and failure. Signal level measuring equipment must be treated with care and re-calibrated regularly to ensure that measurements are accurate and not misleading. Careful and constant recording of signal levels expected at amplifier outputs and selected points on the network is a useful maintenance tool. Sometimes, a specialised preventive maintenance crew is established to allow a more sophisticated approach to the work.

The involvement of installation technicians in preventive maintenance is a worthwhile exercise inasmuch as they will monitor the physical state of street cabinets, manhole covers and junction boxes, and report any decline in signal levels at multitaps.

1.7 Status Monitoring

Many networks have a network management system that routinely checks for signal abnormalities, current and voltage tolerances that are exceeded in active equipment, and the transgression of line powering limits. Since the system can monitor trends it can predict impending service interruptions and allows remedial action to be taken before a failure occurs. It is important that the status monitoring equipment itself is part of the preventive maintenance programme.

1.8 Reliability

Reliability is the probability of a product performing to its full specification during its intended lifetime and under its intended operating parameters. There are four main factors here:-

Probability: Inevitably, production tolerances mean that ostensibly identical items within a group will display different lifetimes. The average lifetime and the spread of these can be expressed in probability terms.

Performance: References to reliability cannot be made without defining and agreeing the required performance limits and a product's failure to meet the criteria is the only consideration used in evaluating it.

Time: Products are manufactured with built-in obsolescence and cannot be assumed to have an indefinite life. The reasons for this are economic, fashionable and technical progress. Therefore, products are designed to operate within their specification for a limited time.

Environment: Electronic products are affected by environmental factors such as temperature, humidity and vibration. Environment plays a highly significant role in determining their lifetime.

1.8.1 Factors Influencing Reliability

Undoubtedly, the most important environmental factor affecting reliability is temperature. The lifetime of semiconductors can be increased significantly by ensuring that the operating temperature is well below the manufacturer's maximum figures. With the high packing density of modern equipment, this becomes more of a problem for the equipment designer. The fitting of heat-sinks and provision of ample ventilation

alleviate the problem. Resistors and electrolytic capacitors also benefit from ambient temperature reduction and this will maximise their operating lives. Resistors must be operated within their wattage ratings and capacitors within their maximum voltage ratings.

Ambient temperature can rise to unacceptable levels within a street cabinet, for instance, and in UK latitudes direct sunlight can produce an equivalent heat of about 800 watts per square metre of incident area. Thermostatically-controlled forced-air cooling should be provided in situations where these conditions are probable. Moisture ingress is another serious enemy of electronic circuitry. Rapid corrosion of unprotected conductors by electrolytic action, and corrosion between dissimilar metals are real and problematical for the cable telecommunication operator. Environmental gaskets should be fitted correctly and any protective insulating barriers should be checked for contamination.

Vibration from heavy plant or vehicles is a further factor that will diminish the life of electronic apparatus. It causes fractures of component leads and circuit boards and rotation of fixing screws and nuts.