LINEMEN'S HANDBOOK

LINE FAULTS

Issue 1, 1976.

Issued to

(Name) [redacted]

(Station) [redacted]

ISSUED BY
GENERAL MANAGER (ENGINEERING)
AUSTRALIAN TELECOMMUNICATIONS
COMMISSION

INTRODUCTION

This Linemens Handbook has been prepared to assist the Lines and Technical staff engaged in the external plant fault localization work and the Lines staff engaged on service restoration and plant repair work.

The Handbook is not intended as a training manual but provides a ready reference for external plant fault localization techniques and repair practices currently in use.

Although fault localization, service restoration and plant repair procedures outlined in this Handbook are applicable throughout the Australian Telecommunications Commission, there may be minor variations in some areas to meet the local conditions. For further information, refer to Australian Telecommunications Commission Engineering Instructions (Headquarters and States).

C Taylor

General Manager (Engineering)
Australian Telecommunications Commission

Treat his home as his castle. Fix the service, clean up, put everything back carefully and wish him good day

CONTENTS

INDEX

INDEX (CONTINUED)

INDEX (CONTINUED)

FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION

WHEN WORKING AT A CUSTOMER'S PREMISES AVOID DIRTYING WALLS WITH YOUR HANDS AND SCRATCHING PAINTED OR POLISHED SURFACES WITH TOOLS OR EQUIPMENT.

FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION

GENERAL

A fault is any condition which interferes with normal working of a service. There are two types of faults:

(i) Equipment Faults - These occur in exchange or substation equipment.

(ii) Line Faults - These occur in external cables, aerial wires and terminating equipment.

The Telecom Commission is informed about equipment and line faults by:

(i) Customers who experience difficulty with their service,

(ii) Results of Routine Maintenance Testing,

(iii) Reports by public or Commission staff who have damaged (or have discovered damage to) Commission equipment or Lines Plant.

LINE FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION

The reported fault details in the metropolitan areas and large provincial centers are recorded and processed at centralized testing centers from which the affected line(s) or equipment are tested and fault clearance activities co-ordinated (see Fig. 1).

LINE FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION (Continued)

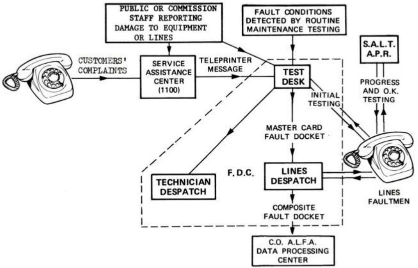


FIG. 1 : TYPICAL FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION IN A METROPOLITAN AREA OR A LARGE PROVINCIAL CENTER

LINE FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION (Continued)

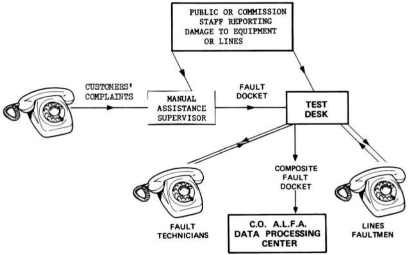


FIG. 2 : TYPICAL FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION IN A SMALL COUNTRY EXCHANGE AREA

LINE FAULT RECEPTION, DETECTION, TESTING AND CLEARANCE ORGANISATION (Continued)

In smaller automatic areas the reported fault details are relayed to the test desk technician for testing and co-ordination of fault clearance activities. In small country exchange areas the fault details are reported to the Manual Assistance Supervisor (see Fig. 2) who completes the Fault Docket and forwards it to the Test Desk technician for testing and co-ordination of fault clearance activities.

OPENING WORKING CABLES

TAKE CARE NOT TO TOUCH ANY POWER WIRES OR POWER FITTINGS ON POWER POLES OR ON TELECOM. POLES.

OPENING WORKING CABLES

GENERAL

Except in emergent conditions, cables carrying trunk or junction circuits and subscribers main cables 100 pair and larger should not be opened without prior instruction or approval from the District or Section Office. A Works Authority may be taken as authority to open cable joints necessary for completion of that work.

Major trunk cables, including coaxial cables and any cables carrying multi-channel carrier circuits must not be opened without the direct authority from the District or Section Office.

For safety precautions associated with opening cables carrying power feed circuits refer to E.I. LINES cables SP 5900.

PRECAUTIONS BEFORE OPENING CABLES

Obtain from the Cable Assigner details of any important circuits, Fire Alarm lines, data circuits etc., which may be affected by the work. (This information will normally be shown on Forms E94 (LR7) and E95 (LR8) where rearrangements or transfers are involved).

Advise the exchange T.T.O. of the proposed work and the circuits which will be affected. Where necessary, users of special circuits (NEX lines) should be notified.

OPENING GAS FILLED CABLES

Do not open cables which are under gas pressure without prior approval from the officer responsible for the maintenance of gas pressure alarm systems. If possible arrange for work of short duration (1-2 days) to be carried out early in the week to allow sufficient time for repressurising the cable before the weekend.

Frequent recharging of the cable with air can cause fatigue cracks in the sheath and joints. It is important, therefore, that all foreseeable work on the cable be carried out while pressure is removed.

Air pressure must never be left off a major trunk, coaxial or junction cable except in cases of emergency and when work is actually being performed on the cable.

Immediately work has been completed arrange for the cable to be recharged with air.

SAFETY PRECAUTIONS

Do not attempt to remove a sleeve from a joint while pressure remains in the cable. To release pressure, remove the Schrader valve or flange screw from the closest test point to the joint being opened. Where there is no test point readily available, make a small cut in the sleeve with a hack knife before applying any heat. Air pressure in the cable at the point where the sleeve is being removed is thus quickly reduced and the possibility of spraying molten metal or causing a fire in the joint is considerably reduced.

DO NOT PRICK THE INSULATION OF PLASTIC INSULATED CONDUCTORS.

PRECAUTIONS DURING JOINTING OPERATIONS

Do not make alterations to working pairs other than those shown on transfer sheets without obtaining prior approval and consulting the Cable Assigner. Make sure vacant pairs are clear of faults before cutting them into working circuits.

Make transfers wire by wire to avoid reversing the two legs of a pair. Faults will be caused if the 'A' and 'B' legs of pairs carrying Public Telephones, Junction, Trunk or special circuits are reversed. Circuits of this nature will be indicated on Transfer sheets (Forms E94 (LR7) and E95 (LR8)).

Before cutting wires make sure that a conversation is not in progress.

Bond lead cable sheaths across the sheath opening before removing the sleeve for protection against electric shock and to ensure that electrolytic protection is maintained and any earth return circuits are not interrupted.

Where work on a joint is incomplete at the end of the day adequate precautions must be taken to prevent moisture entering the joint. Fit a temporary lead sleeve on all trunk and junction cables and in all cases where there is any possibility of the manhole being flooded. Use rubber bandages in safe locations only and for no longer than a single night unless special approval is given by the District or Section Office.

On completion of plumbing, pressure test joints in cables 100 pairs and over as well as in cables containing trunk or junction circuits.

DEFINITIONS - STANDARD LINE CONDITIONS

IF YOU USE A CUSTOMER'S LINE TO RING A METERING NUMBER, ARRANGE WITH THE EXCHANGE TECHNICIAN TO HAVE THE CALL REBATED.

VACANT LINE - A line which is installed and is available for connection into service (see Fig. 1).

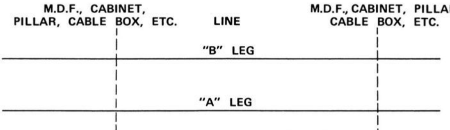


FIG. 1 : VACANT LINE

DIRECT EXCHANGE LINE - NO CALL IN PROGRESS

A line connected to a Step by Step Exchange is shown in Fig. 2.

A line connected to a Crossbar Exchange is shown in Fig. 3.

DIRECT EXCHANGE LINE - CALL IN PROGRESS

A line connected to a Step by Step or Crossbar Exchange is shown in Fig. 4.

DO NOT EAT, DRINK OR SMOKE WHILE HANDLING LEAD.

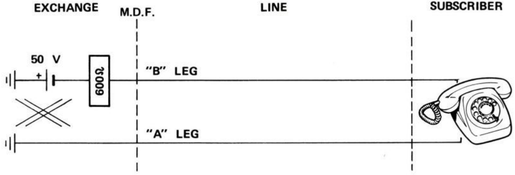


FIG. 2 : DIRECT EXCHANGE (STEP BY STEP) LINE - NO CALL IN PROGRESS

DEFINITIONS – STANDARD LINE CONDITIONS

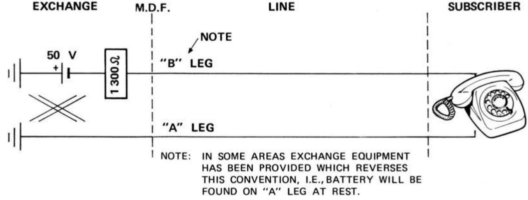


FIG. 3 : DIRECT EXCHANGE (CROSSBAR) LINE - NO CALL IN PROGRESS

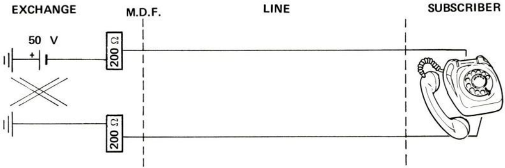


FIG. 4 : DIRECT EXCHANGE LINE - CALL IN PROGRESS

DEFINITIONS – STANDARD LINE CONDITIONS

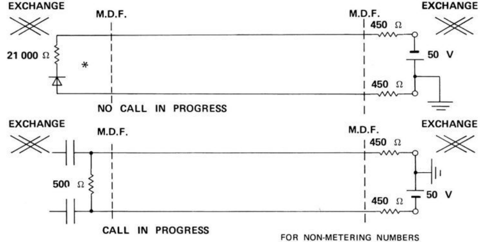


FIG. 5 : CROSSBAR TO CROSSBAR JUNCTION LINE

JUNCTION LINE - Typical junction lines are shown in Figs. 5, 6, 7 and 8.

*NOTE: Values given in these Figures are representative of equivalent exchange equipment resistances for some typical junction circuits only.

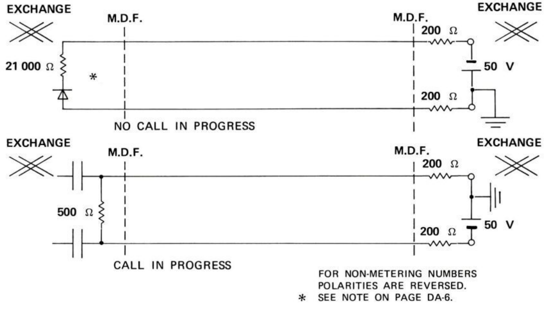
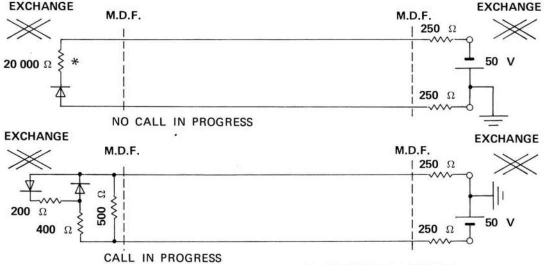


FIG. 6 : CROSSBAR TO STEP BY STEP JUNCTION LINE



FOR NON-METERING NUMBERS
POLARITIES ARE REVERSED.
* SEE NOTE ON PAGE DA-6.

FIG. 7 : STEP BY STEP TO CROSSBAR JUNCTION LINE

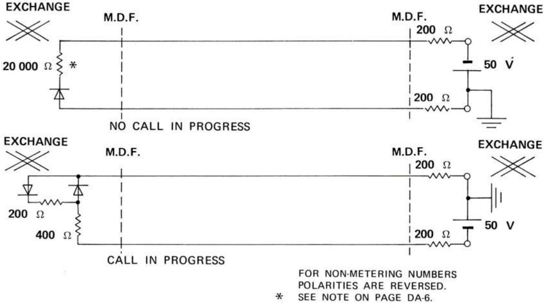


FIG. 8 : STEP BY STEP TO STEP BY STEP JUNCTION LINE

TRUNK LINE - Typical trunk lines are shown in Fig. 9.

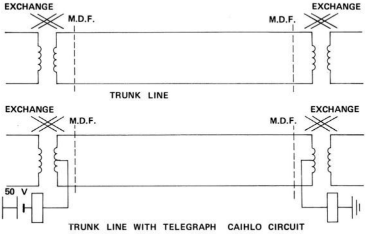


FIG. 9 : TRUNK LINES

NON-EXCHANGE LINE - The non-exchange lines are used as Private Lines and Control Lines, as well as for such purposes as Telegraph, Data Transmission, Fire Alarms, Burglar Alarms, etc. A Fire Alarm line is shown in Fig. 10.

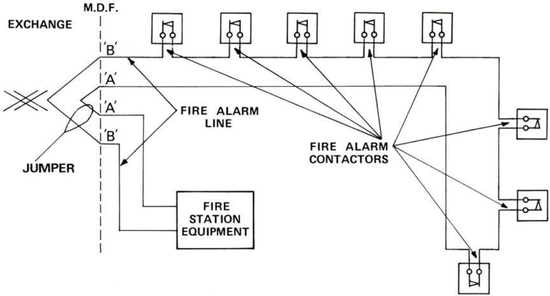


FIG. 10 : FIRE ALARM LINE

PLACE GUARDS AROUND OPEN JOINTING PITS.

DEFINITIONS - LINE FAULTS

WORK SAFELY AND MAKE SAFETY PRECAUTIONS A PART OF THE JOB. BE CONSTANTLY ON GUARD AGAINST AN ACCIDENT AND DO NOT START A JOB UNTIL YOU ARE SURE THAT YOU CAN WORK SAFELY.

Issue 1, 1976

DEFINITIONS – LINE FAULTS

GENERAL

LINE FAULT is a condition of Line Plant which is sub-standard and which may have a wide ranging effect on service varying from unnoticeable to a complete failure of service.

In general, LINE FAULTS either make additional paths for the current other than through the normal circuit or equipment or break the continuity of the circuit.

INTERMITTENT LINE FAULT is a condition which "comes and goes", e.g., an INTERMITTENT SHORT CIRCUIT fault on a line is where the legs of the line touch each other occasionally.

INCIPIENT LINE FAULT is a non-service affecting condition which, if not corrected, will result in a fault leading to degradation or loss of service.

TYPES OF FAULTS

SHORT CIRCUIT (S/C). A condition where the legs of the line are in physical contact with each other or where a conductive path between them exists, such as the electrolytic paths present in wet paper insulated cables (see Fig. 1).

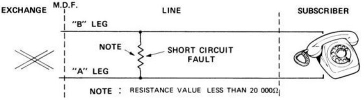


FIG. 1 : SHORT CIRCUIT FAULT

TYPES OF FAULTS (Continued)

CROSS OR CONTACT (X). A condition where one or both legs of the line are in physical contact with one or both legs of another line or where a conductive path between them exists, such as the path present when "shiners' in a joint contact one another, or where, as in the S/C case, electrolytic paths are present in wet paper insulated cables (see Fig. 2).

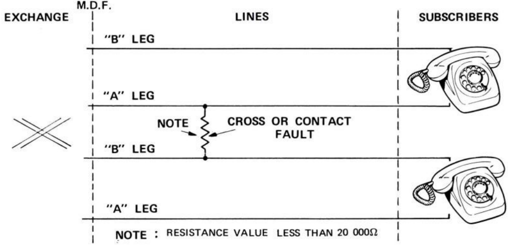


FIG. 2 : CROSS OR CONTACT FAULT

TYPES OF FAULTS (Continued)

EARTH (Eth) OR GROUND (Gnd). A condition where one or both legs of the line are in physical contact with an earthed object or where a conductive path, such as the conductive path present when a wet limb contacts an open wire line, exists between leg(s) and an earthed object (see Fig. 3).

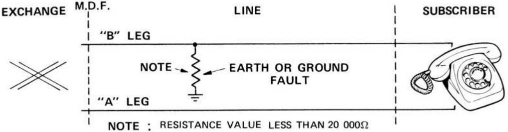


FIG. 3 : EARTH OR GROUND FAULT

LOW INSULATION RESISTANCE (L.I.R. OR LOW I.R.). A condition where current leakage occurs between the leg(s) of the line or between leg(s) and other line conductor(s) and/or an earthed object. Fig. 4 illustrates a LOW INSULATION RESISTANCE fault in a line where current leakage occurs between "A" and "B" legs.

TREAT ALL POWER WIRES AND FITTINGS ON POWER POLES AS "LIVE" AND DANGEROUS.

TYPES OF FAULTS (Continued)

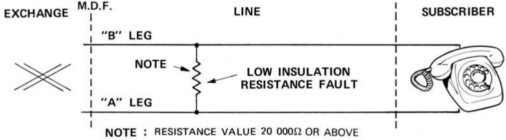


FIG 4 : LOW INSULATION RESISTANCE BETWEEN LEGS

Subject to Local Instructions, INSULATION RESISTANCE of .5MΩ (500 000 Ω) is regarded as being the threshold of a Workable Line condition. Where a policy of up-grading plant is being implemented a minimum value of 1MΩ(1 000 000 Ω) would normally be aimed at.

However, most services connected to Crossbar and Step by Step exchanges will operate with the INSULATION RESISTANCE as low as 50K Ω (50 000 Ω) without noticeable impairment to service. Below this figure, possibly down to 20K Ω (20 000 Ω), the service would work but may be impaired by such problems as noise, crosstalk, incorrect numbers and ring trips.

Below 20K Ω (20 000 Ω), some services may operate satisfactorily, but will be unreliable and should be regarded as unworkable.

TYPES OF FAULTS (Continued)

FOREIGN BATTERY (F.B.). A condition where a L.I.R. or CONTACT fault is connecting a line to another line which carries voltage, thus resulting in the former line exhibiting P.D. between ground and leg(s) after all telephone apparatus has been removed from it (see Fig. 5).

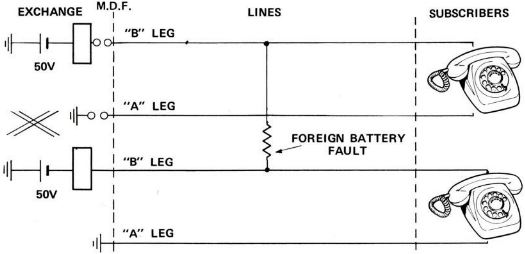


FIG. 5 : LOW INSULATION RESISTANCE FAULT BETWEEN LEGS OF DIFFERENT LINES RESULTING IN FOREIGN BATTERY

TYPES OF FAULTS (Continued)

OPEN CIRCUIT (O/C). A condition where continuity of one or both legs of the line is broken, preventing the flow of current (see Fig. 6).

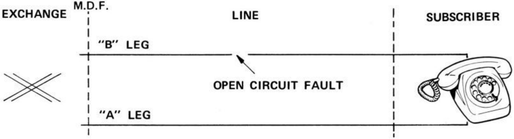


FIG. 6 : OPEN CIRCUIT FAULT

SECURE THE LADDER TO THE POLE AND FASTEN YOUR SAFETY BELT BEFORE COMMENDING WORK.

TYPES OF FAULTS (Continued)

HIGH RESISTANCE (H.R.). A condition where the loop resistance of the line is higher than it should be (see Fig. 7). H.R. faults usually occur only at joints and terminating equipment.

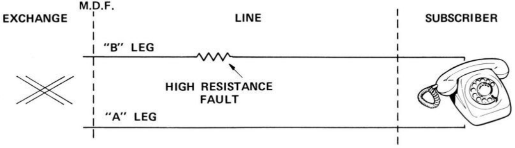


FIG. 7 : HIGH RESISTANCE FAULT

TEST CROSSARMS AND POLE FITTINGS BEFORE TRUSTING THEM TO SUPPORT YOU.

TYPES OF FAULTS (Continued)

TRANSPOSED PAIRS (T.P.). A condition where one line is connected in error to another line (see Fig. 8).

NOTE: It is permissible to transpose pairs when random jointing, provided the condition is "straightened" at the straightening joint so that the terminal readings are in numerical sequence and coincide with the MDF (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1).

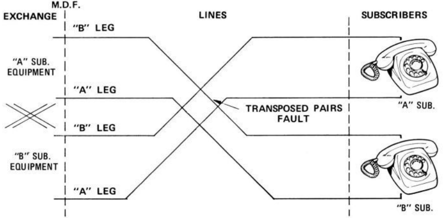


FIG. 8 : TRANSPOSED PAIRS FAULT

TYPES OF FAULTS (Continued)

SPLIT PAIRS (S.P.). A condition where a leg of the line is wrongly connected to a leg of another line (see Fig. 9).

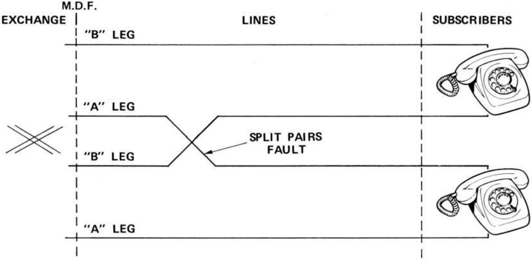


FIG. 9 : SPLIT PAIRS FAULT

TYPES OF FAULTS (Continued)

REVERSED LEGS (R.L.). A condition where the polarity of the line is reversed due to the connection of the "A" leg to the "B" leg and vice versa. This condition affects special circuits, such as P.T. and PABX Exchange lines etc. (see Fig. 10).

NOTE: ~~It is permissible to reverse the legs when random jointing, provided the correct line polarity is reinstated at the straightening joint (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1~~).

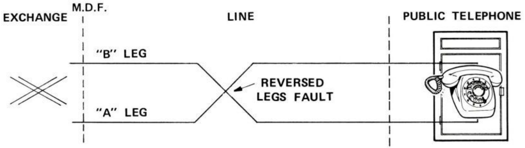


FIG. 10 : LINE POLARITY REVERSED DUE TO REVERSED LEGS FAULT

TYPES OF FAULTS (Continued)

"RECTIFIED" SPLIT PAIRS. A condition where the split pairs have been split at another joint or connection in order to reinstate the continuity of the original circuit (see Fig. 11). This condition causes crosstalk.

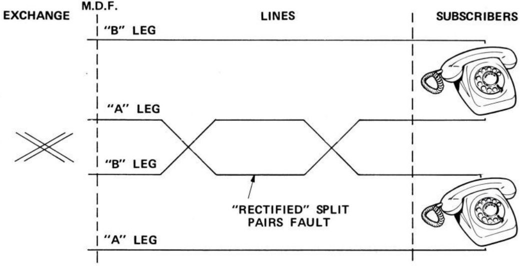


FIG. 11 : "RECTIFIED" SPLIT PAIRS FAULT

DEFINITIONS – LINE FAULTS

TYPES OF FAULTS (Continued)

COAXIAL TUBE FAILURE. A condition where the tube is unable to transmit either carrier signal or power feed current.

COAXIAL TUBE IMPEDANCE IRREGULARITY. A condition where carrier transmission is impaired but not interrupted and where the coaxial tube can be used for power feeding.

MAJOR PLANT BREAKDOWN. A condition where a considerable number of lines are failing or have failed.

DO NOT ENTER PRIVATE PROPERTY OR DO ANY WORK THEREIN IN THE ABSENCE OF THE CUSTOMER OR A RESPONSIBLE PERSON.

PREVENT PEOPLE STEPPING INTO OPEN PITS BY ERECTING GUARDS BEFORE REMOVING A COVER.

TYPICAL CAUSES OF FAULTS

Typical causes of faults in various types of lines plant are given in Table 1.

TYPE OF FAULT	TYPICAL CAUSES OF FAULTS			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
SHORT CIRCUIT (S/C), CROSS OR CONTACT (X))* (*May be associated with FOREIGN BATTERY (F.B.))	(i) Damaged conductor insulation. (ii) Misplaced sleeves. (iii) Water in cable.	PILLARS & CABINETS (i) Overtension of jumper wire(s). (ii) Excessive stripping of jumper wire(s) (iii) Damaged insulation on jumper wire(s). (iv) Excessive solder on tag(s). (v) Water in cable tail.	AERIAL CABLE (i) Damaged plastic insulation. (ii) Misplaced sleeves. DROP WIRE Staple crushing lead-in.	(i) Incorrect tension. (ii) Movement of poles due to loose stays, etc. (iii) Insufficient spacing between open wires. (iv) Defective insulation on bridle wires. (v) Flying objects, tree limb(s),

TABLE 1 - TYPICAL CAUSES OF FAULTS IN LINES PLANT (Continued next page)

TYPICAL CAUSES OF FAULTS (Continued)

TYPE OF FAULT	TYPICAL CAUSES OF FAULTS			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
SHORT CIRCUIT (S/C), (Continued)				bare wire laying across bare aerial conductors.
EARTH (Eth.) OR GROUND (Gnd.)	(i) Water in cable. (ii) Damaged conductor insulation. (iii) Misplaced sleeve(s).	PILLARS AND CABINETS (i) Water in cable tail. (ii) Damaged insulation on jumper wires allowing wire to contact frame. PROTECTED TERMINAL BOXES Operated arrester(s).	AERIAL CABLE (i) Damaged plastic insulation. (ii) Misplaced sleeve(s).	Contact with earthed fitting(s).

TABLE 1 - TYPICAL CAUSES OF FAULTS IN LINES PLANT (Continued next page)

TYPICAL CAUSES OF FAULTS (Continued)

TYPE OF FAULT	TYPICAL CAUSES OF FAULTS			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
LOW INSULATION RESISTANCE (L.I.R. or Low I.R.) * (*May be associated with Foreign Battery (F.B.))	(i) Ingress of moisture into cable due to defective cable sheath. (ii) Ingress of moisture into cable due to defective joint seal.	(i) Condensation of moisture inside the equipment. (ii) Ingress of moisture into cable tail (where applicable) due to defective sheath. (iii) Corrosion Products (Verdigris). (iv) Spiderwebs.	(i) Ingress of moisture into cable due to defective cable sheath. (ii) Ingress of moisture into cable due to defective joint seal.	(i) Contact with trees, shrubs. (ii) Contact with cross-arm(s). (iii) Cracked or dirty insulator(s). (iv) Birds nest(s).

TABLE 1 - TYPICAL CAUSES OF FAULTS IN LINE PLANT (Continued next page)

TYPICAL CAUSES OF FAULTS (Continued)

TYPE OF FAULT	TYPICAL CAUSES OF FAULTS			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
OPEN CIRCUIT (O/C)	(i) Corrosion. (ii) Excessive cranking of twist joints. (iii) Mechanical damage to cable. (iv) Faulty conductor joint(s). (v) Incorrectly adjusted jointing tool.	PILLARS AND CABINETS Corroded or broken jumper wire(s). TERMINAL BOXES AND BLOCKS (i) Loose nut(s) on terminal(s). (ii) Verdigris on terminal(s). (iii) Operated fuse(s).	AERIAL CABLE (i) Gunshot damage. (ii) Conductor fatigue in span due to wind as a result of lack of twist being placed in cable during erection. (iii) Incorrect conductor stripping technique.	(i) Overtensioning. (ii) Poorly fitted press type sleeve(s). (iii) Falling tree limbs. (iv) Damage by high vehicle. (v) Broken bridle wire. (vi) Corrosion at Drip Point(s).

TABLE 1 - TYPICAL CAUSES OF FAULTS IN LINES PLANT (Continued next page)

TYPICAL CAUSES OF FAULTS (Continued)

TYPE OF FAULT	TYPICAL CAUSES OF FAULTS			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
OPEN CIRCUIT (O/C) (Continued)			(iv) Excessive cranking of twist joint(s).	
HIGH RESISTANCE (H.R.)	(i) Loose unsoldered twist joint(s). (ii) Incorrectly made connector joint(s).	PILLARS AND CABINETS Dry joint(s) in jumper wire termination(s). TERMINAL BOXES AND BLOCKS (i) Loose nut(s) on terminal(s). (ii) Verdigris on terminals. (iii) Loose or corroded fuse mountings. (iv) Corroded fuse ends.	AERIAL CABLE (i) Loose twist joint(s). (ii) Defective connector joint(s).	(i) Loose or dirty line wire connection(s). (ii) Loose or dirty terminal connection(s). (iii) Corrosion at Drip Point(s).

TABLE 1 - TYPICAL CAUSES OF FAULTS IN LINES PLANT (Continued next page)

TYPICAL CAUSES OF FAULTS (Continued)

TYPE OF FAULT	TYPICAL CAUSES OF FAULTS			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
TRANSPOSED PAIRS (T.P.), SPLIT PAIRS (S.P.), REVERSED LEGS (R.L.), "RECTIFIED" SPLIT PAIRS	Jointing error.	Terminating error.	Jointing error.	Installation error.
MAJOR PLANT BREAKDOWN	PAPER INSULATED CABLE Failure of cable sheath allowing water to enter. ALL TYPES OF CABLE (i) Flood. (ii) Explosion. (iii) Fire. (iv) Mechanical damage.	(i) Mechanical damage. (ii) Flood. (iii) Explosion. (iv) Fire.	AERIAL CABLE (i) Storm. (ii) Fire. (iii) Flood. (iv) Fallen tree. (v) Damage by high vehicle.	(i) Storm. (ii) Fire. (iii) Flood. (iv) Fallen tree. (v) Damage by high vehicle.

TABLE 1 - TYPICAL CAUSES OF FAULTS IN LINES PLANT

PRINCIPLES OF LINE FAULT LOCALIZATION

IF A TOOL IS DEFECTIVE DO NOT USE IT.

PRINCIPLES OF LINE FAULT LOCALIZATION

GENERAL

Although the methods and instruments used for localization of line faults are continually being improved, there is still no single universally applicable technique available. The most suitable fault localization technique in each case is determined by the type of plant, type of fault, number of services affected, type of available instruments, etc. It should also be noted that in various situations two or more fault localization techniques may be used to localize a particular fault.

This results in a considerable overlap, and many gaps, in the capabilities of the available fault localization techniques. A thorough knowledge of fault localization methods and instruments is therefore essential for selection of the best approach to a particular fault situation.

The success in line fault localization work is measured by the time and effort, with the least disturbance to plant, required to localize a fault. Therefore, a well planned, systematic approach in this work is of particular importance.

WATCH OUT FOR TRAINS WHEN WORKING ALONG RAILWAY LINES.
USE A FLAGMAN WHERE THERE IS ANY DANGER TO WORKMEN OR TO TRAINS.

PRINCIPLES OF LINE FAULT LOCALIZATION

ELEMENTS OF FAULT LOCALIZATION

The main elements of line fault localization work are:

(i) STUDY OF TEST RESULTS, SERVICE HISTORY AND LINES PLANT LAY-OUT,
(ii) OBSERVATION,
(iii) UTILIZATION OF G.P.A. SYSTEMS,
(iv) ELECTRICAL TESTING FROM EXCHANGE TEST DESK,
(v) USE OF AUTO TEST DESK FACILITIES,
(vi) ELECTRICAL TESTING IN THE FIELD,
(vii) LOGICAL DEDUCTION.

Systematic and logical application of these elements will eliminate inefficiency, such as, for example any tendency to open cable joints at random to locate a cable fault. IT MUST BE A PRIME OBJECTIVE OF THE LINES FAULTMAN TO LOCALIZE THE FAULT WITH A MINIMUM DISTURBANCE TO PLANT, PARTICULARLY CABLE JOINTS.

It should be noted that element (i) (STUDY OF TEST RESULTS, SERVICE HISTORY AND LINES PLANT LAY-OUT) is required as the first step in the case of each fault. The order of application of other elements may vary, dependent on the circumstances and nature of the particular fault.

STUDY OF TEST RESULTS, SERVICE HISTORY AND LINES PLANT LAY-OUT

Before starting work on fault localization, the Lines Faultman or any other officer engaged on line fault localization work, is required to enter into the Faultman's notebook the following details supplied by FAULT DESPATCH or TEST DESK (see pages B-2 to B-5 of this Handbook).

STUDY OF TEST RESULTS, SERVICE HISTORY AND LINES PLANT LAY-OUT (Continued)

ISOLATED LINE FAULTS

(i) TYPE OF FAULT,
(ii) CUSTOMER'S TELEPHONE NUMBER,
(iii) NAME AND ADDRESS,
(iv) SUMMARY OF FAULT HISTORY OF THE CUSTOMER'S SERVICE,
(v) ANY OTHER INFORMATION WHICH MAY ASSIST IN LOCALIZING FAULT, SUCH AS KNOWN INSTANCES OF SUBSTANDARD LINES PLANT CONDITIONS.

MULTIPLE LINE FAULTS AND MAJOR PLANT BREAKDOWNS

(i) PREDOMINANT TYPE OF FAULTS,
(ii) CABLE(S), CABINET(S), PILLAR(S) OR AERIAL ROUTE(S) AFFECTED,
(iii) FULL RANGE OF AFFECTED PAIRS,
(iv) G.P.A. INFORMATION, IF APPLICABLE,
(v) ANY OTHER INFORMATION WHICH MAY ASSIST IN LOCALIZING FAULT, SUCH AS KNOWN INSTANCES OF SUBSTANDARD LINES PLANT CONDITIONS.

Useful information can be obtained, before proceeding to the fault, by studying the relevant lines plant plans (copies of which are available in the Lines Depot) to become familiar with the lines plant lay-out in the affected locality and to determine the location of terminating points (cabinets, pillars, etc.) from which electrical tests can be made, e.g., tests using Lines Test Set No. 1 to establish range of pairs affected. Where MULTIPLE LINE FAULTS are involved, the study of the lines plant lay-out is particularly important for efficient fault localization. For MULTIPLE LINE FAULTS and MAJOR LINE PLANT BREAKDOWNS local enquiries should be made to determine if (and where) there were in the affected locality any recent:

(i) DIGGING OR CLEARING OPERATIONS, ROADWORKS,
(ii) ROAD ACCIDENT(S) INVOLVING COMMISSION PLANT,
(iii) FLOOD(S),
(iv) EXPLOSION(S),
(v) FIRE(S),
(vi) LANDSLIDES, UPROOTED TREES,
(vii) STORM(S),
(viii) CABLE JOINTING WORKS IN PROGRESS (OR RECENTLY COMPLETED).

PRINCIPLES OF LINE FAULT LOCALIZATION

OBSERVATION

Observation is a vital part of fault localization work and is often the easiest way to quickly locate a fault. Examples of points to check in the affected locality are:

(i) Pole leaning,
(ii) Loose stay - broken stay,
(iii) Open wire(s) (bare) contacting staywires, trees, etc.,
(iv) Aerial wire(s) broken in span,
(v) Open wires (bare) contacting each other in span,
(vi) Recent digging or road works close to Commission cable route,
(vii) Broken terminating equipment,
(viii) Unsoldered jumper wire terminations,
(ix) Moisture in terminating equipment,
(x) Broken jointing pit or manhole,
(xi) Warm lead sheath or lead sleeve,
(xii) Cable joint unsupported in jointing pit or manhole,
(xiii) Vehicle ruts across cable trench.

UTILIZATION OF G.P.A. SYSTEMS

The cable fault location facilities provided by the G.P.A. systems include:

(i) When a contractor alarm operates, its location (and hence the location of the defective section of the cable) can be determined by measuring the loop resistance of the alarm circuit.

(ii) The fault is further localized by measuring the air pressure gradient in the cable along its length. A low pressure point indicates the vicinity of the fault.

UTILIZATION OF G.P.A. SYSTEMS (Continued)

(iii) Precise fault location can be made by applying an approved foaming solution to joints and exposed cables in jointing chambers, listening for escaping air or by injecting a halide gas into the cable and searching over the suspect section with an electronic locator.

(iv) Tracer gas and special detectors, in the hands of Cable Protection specialists may be used for precise locations.

ELECTRICAL TESTING

All types of electrical testing, e.g., TESTING FROM EXCHANGE TEST DESK, USE OF AUTO TEST DESK FACILITIES and TESTING IN THE FIELD are used to:

(i) CONFIRM THE REPORTED FAULT CONDITION,
(ii) DETERMINE ITS EXTENT,
(iii) LOCALIZE AND PRECISELY LOCATE THE FAULT,
(iv) VERIFY THAT THE LINE IS O.K. AFTER COMPLETION OF REPAIR WORK.

In general, ELECTRICAL TESTING IN THE FIELD includes the following consecutive elements:

(i) FAULT LOCALIZATION BY SECTIONALIZATION OF LINES PLANT,
(ii) PRECISE FAULT LOCATION.

FAULT LOCALIZATION BY SECTIONALIZATION OF LINES PLANT

These tests, which include the use of Lines Test Set No. 1 and Buttinski, are normally made from a Terminal Block, Terminal Box, Pillar, Cabinet or M.D.F., to ascertain in which section of the lines plant the fault is situated.

ELECTRICAL TESTING (Continued)

PRECISE FAULT LOCATION

Once the faulty section of the lines plant has been ascertained, the fault is accurately located within this section by an appropriate electrical testing technique, such as, for example, Tone/Search or Bridge measurements.

LOGICAL DEDUCTION

Fault localization work consists of both easier and more difficult situations.

While the easier to localize faults, which are in the majority, do generally require a systematic approach, it is in the case of the more difficult ones that only a particularly well planned collection and logical study of all the relevant information (see ELEMENTS OF FAULT LOCALIZATION, page E-3) will enable a Lines Faultmen to do a quick and efficient fault localization.

ALWAYS WEAR A SAFETY BELT AND TAKE A SAFETY LINE WHEN YOU CLIMB A POLE.

LOCALIZATION OF ISOLATED LINE FAULTS

WORK SAFELY AND MAKE SAFETY PRECAUTIONS PART OF THE JOB.

Issue 1, 1976

LOCALIZATION OF ISOLATED LINE FAULTS

GENERAL

Of the many techniques available for the localization of ISOLATED LINE FAULTS, e.g., faults involving a small number of pairs, typically one or two pairs, the choice of the most suitable technique in each individual case is determined by the type of fault (see Section DB, pages DB-2 to DB-12 inclusive, of this HANDBOOK), type of plant, type of available instruments and the experience and skill of the officer engaged on fault localization work.

The general principles of localizing LINE FAULTS are given in Section E of this HANDBOOK.

TYPICAL FAULT LOCALIZING PROCEDURE

(i) TEST RESULTS, SERVICE HISTORY, PLANT LAY-OUT - Before proceeding to the fault, study the information supplied by FAULT DESPATCH or TEST DESK. It is also necessary to be thoroughly familiar with the lines plant lay-out in the affected locality. In most cases, this study will indicate the type of affected lines plant (e.g., UNDERGROUND CABLE, TERMINATING EQUIPMENT etc.) and help to quickly localize the fault.

(ii) TESTING VACANT PAIRS - Test a number of vacant pairs (if applicable) to verify that the fault in hand is an ISOLATED LINE FAULT. Localization of MULTIPLE LINE FAULTS is described in Section FB of this HANDBOOK.

(iii) LOCALIZATION OF FAULT BY SECTIONALIZATION OF LINES PLANT - Open the leg(s) of the faulty line at the Terminal Block, Terminal Box, Pillar, Cabinet or MDF and prove in which direction the fault lies until the faulty section is isolated.

TYPICAL FAULT LOCALIZING PROCEDURE (Continued)

CABLE JOINTS, INCLUDING OPENABLE JOINTS, SHOULD BE DISTURBED ONLY AS A LAST RESORT. TAKE FULL ADVANTAGE OF THE USE OF INSTRUMENTS FOR FAULT LOCALIZATION. The Order in which the test point(s) are selected may be indicated by the fault information, e.g., in the case of a Foreign Battery Fault opening the line at the 1 pair Terminal Block would not be appropriate. The details of testing procedures associated with the localization of ISOLATED LINE FAULTS into a section of lines plant are described in the following sections of LINEMENS HANDBOOK, LINES TESTING AND INSTRUMENTS:

Section GA, USE OF LINES TEST SET NO. 1,
Section N, USE OF TEST HANDSET (BUTTINSKI).

(iv) LOCAL ENQUIRIES AND INSPECTION OF AFFECTED LOCALITY - Observation and local enquiries (for examples of items to look for which could be the cause of the fault(s) see page E-5 of this HANDBOOK) are vital parts of fault localization work and are often the easiest ways to quickly localize a fault.

(v) PRECISE LOCATION OF THE FAULT - Once the faulty section of the lines plant has been isolated the fault is accurately located (see NOTE below) within this section, as outlined in Table 1.

NOTE: All testing procedures referred to in Table 1 are described in detail in LINEMENS HANDBOOK, LINES TESTING AND INSTRUMENTS.

KEEP A SHARP LOOKOUT FOR TRAINS WHEN WORKING ALONG RAILWAY LINES.

TYPICAL FAULT LOCALIZING PROCEDURE (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
SHORT CIRCUIT) (S/C),) CROSS OR)* CONTACT) (X)) (*May be associated with FOREIGN BATTERY (F.B.))	PLASTIC INSULATED CABLE Use Tone/Search* technique, pages JA-11 to 13 inclusive. *Note: This technique is usually satisfactory only if access to the cable sheath at a jointing pit or manhole is available. ALL TYPES OF CABLE (i) Use Varley Test, pages JB-21 and 22 (Hand Operated	PILLARS AND CABINETS Check for: . Overtension of jumper wire(s), . Excessive stripping of insulation on jumper wire(s), . Damaged insulation on jumper wire(s), . Excessive solder on tag(s). ALL TYPES OF TERMINATING EQUIPMENT If fault is suspected in	AERIAL CABLE Test as for UNDERGROUND CABLE, ALL TYPES OF CABLE. DROP WIRE Check for staple crushing lead-in.	(i) Check for: . Incorrect tension, . Movement of poles due to loose stays, etc., . Insufficient spacing between wires, . Defective insulation on bridle wires, . Flying

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
SHORT CIRCUIT) (S/C),) CROSS OR)* CONTACT) (X)) (* May be associated with FOREIGN BATTERY (F.B.)) (Continued)	Megger) or pages JC-10 to 14 inclusive (Transistorised Megger). (ii) Use Three Wire technique, Section JF. (iii) Use Pulse Echo technique, Section JD.	cable tail, test as for UNDERGROUND CABLE.		objects, tree limb(s), bare wire laying across bare aerial conductors. (ii) Use Transistorised Bridge Megger LOW BRIDGE VOLTS Varley Test, pages JC-10 to 14 inclusive. (iii) Use Three Wire technique, Section JF. (iv) Use Pulse Echo technique, Section JD.

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
EARTH (Eth.) or GROUND (Gnd.)	PLASTIC INSULATED CABLE Use Tone/Search technique, pages JA-2 to 5 inclusive. ALL TYPES OF CABLE (i) Use Varley Test, pages JB-8 to 20 inclusive for Hand Operated Megger or pages JC-8 to 14 inclusive for Transistorised Megger. (ii) Use Three	ALL TYPES OF TERMINATING EQUIPMENT If fault is suspected in cable tail, test as for UNDERGROUND CABLE. PROTECTED TERMINAL BOXES Check for operated arrester(s).	AERIAL CABLE Test as for UNDERGROUND CABLE, ALL TYPES OF CABLE.	(i) Check for: contact with earthed fitting(s). (ii) Use Transistorised Bridge Megger LOW BRIDGE VOLTS Varley Test, pages JC-8 to 14 inclusive. (iii) Use Three Wire technique, Section JF. (iv) Use Pulse Echo, technique, Section JD.

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
EARTH (Eth.) or GROUND (Gnd.) (Continued)	Wire technique, Section JF. (iii) Use Pulse Echo technique, Section JD.			
LOW INSULATION RESISTANCE (L.I.R. or LOW I.R.)* (* May be associated with FOREIGN BATTERY (F.B.))	(i) Use Varley Test, pages JB-8 to 20 inclusive for Hand Operated Megger or pages JC-8 to 14 inclusive for Transistorised Megger. (ii) Use Three Wire technique, Section JF.	(i) Check for: . Moisture inside the equipment, . Verdigris, . Spiderwebs. (ii) If fault is suspected in cable tail, test as for UNDERGROUND CABLE.	AERIAL CABLE Test as for UNDERGROUND CABLE, ALL TYPES OF CABLE.	(i) Check for: . Contact with trees, shrubs, . Contact with cross-arm(s), . Cracked or dirty insulator(s) . Birds nest(s). (ii) Use Transistorised Bridge

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
LOW INSULATION RESISTANCE (L.I.R. or LOW I.R.)* (*May be associated with FOREIGN BATTERY (F.B.)) (Continued)				Megger LOW BRIDGE VOLTS Varley Test pages JC-8 to 14 inclusive. (iii) Use Three Wire technique, Section JF.
OPEN CIRCUIT (O/C)	(i) Apply Locating Disconnexion technique using Transistorised Bridge Megger, pages JC-14 to 18 inclusive.	PILLARS AND CABINETS Check for corroded or broken jumper wire(s).	AERIAL CABLE Test as for UNDERGROUND CABLE.	(i) Check for: . Broken line wires(s), . Broken bridle wire(s),

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
OPEN CIRCUIT (O/C) (Continued)	(ii) Use Pulse Echo technique, Section JD.	TERMINAL BOXES AND BLOCKS Check for: . Loose nut(s) on terminal(s), . Verdigris on terminal(s), . Operated fuse(s). ALL TYPES OF TERMINATING EQUIPMENT If fault is suspected in cable tail, test as for UNDERGROUND CABLE.		. Corroded Drip Point(s). (ii) Test as for UNDERGROUND CABLE.

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
HIGH RESISTANCE (H.R.)	Use Pulse Echo technique, Section JD.	PILLARS AND CABINETS Check for dry joint(s) in jumper wire termination(s). TERMINAL BOXES AND BLOCKS Check for: . Loose nut(s) on terminal(s), . Verdigris on terminal(s), . Loose or corroded fuse mountings, . Corroded fuse ends.	AERIAL CABLE Test as for UNDERGROUND CABLE.	(i) Check for: corroded Drip Point(s), (ii) Test as for UNDERGROUND CABLE.

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
HIGH RESISTANCE (H.R.) (Continued)		ALL TYPES OF TERMINATING EQUIPMENT If fault is suspected in cable tail, test as for UNDERGROUND CABLE.		
TRANSPOSED PAIRS (T.P.)	Use process of elimination.	Use process of elimination.	Use process of elimination.	Use process of elimination.
SPLIT PAIRS (S.P.)	(i) Use Pulse Echo technique Section JD. (ii) Use process of elimination.	Test as for UNDERGROUND CABLE.	Test as for UNDERGROUND CABLE.	Test as for UNDERGROUND CABLE.
REVERSED LEGS (R.L.)	Use process of elimination.	Use process of elimination.	Use process of elimination.	Use process of elimination.

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS (Continued next page)

TYPICAL FAULT LOCALIZING PROCEDURES (Continued)

TYPE OF FAULT	TYPE OF LINES PLANT			
	UNDERGROUND CABLE	TERMINATING EQUIPMENT	AERIAL CABLE AND DROP WIRE	OPEN WIRE LINES
"RECTIFIED" SPLIT PAIRS	(i)Use Pulse Echo technique, Section JD. (ii)Use process of elimination.	Test as for UNDERGROUND CABLE.	Test as for UNDERGROUND CABLE.	Test as for UNDERGROUND CABLE.

TABLE 1 : PRECISE LOCATION OF ISOLATED LINE FAULTS

DON'T REMAIN ALOFT OR HANDLE WIRES DURING A THUNDER STORM.

LOCALIZATION OF MULTIPLE LINE FAULTS

NEVER WALK OR STAND ON STACKED POLES UNLESS THEY ARE PROPERLY SECURED.

Issue 1, 1976

LOCALIZATION OF MULTIPLE LINE FAULTS

GENERAL

The selection of the most suitable technique for localization of a MULTIPLE LINE FAULT, e.g., a fault where an item of lines plant has failed at a point causing degradation of a number (usually a range) of circuits, is determined in each individual case by the predominant type of fault (see Section DB, pages DB-2 to DB-13 inclusive, of this HANDBOOK), type of plant, type of available instruments and the experience and skill of the officer engaged on fault localization work.

The general principles of localizing LINE FAULTS are given in Section E of this HANDBOOK.

TYPICAL FAULT LOCALIZING PROCEDURE

(i) TEST RESULTS, SERVICE HISTORY, PLANT LAY-OUT - Before proceeding to the fault, study the information supplied by FAULT DESPATCH or TEST DESK. It is also necessary to be thoroughly familiar with the lines plant lay-out in the affected locality.

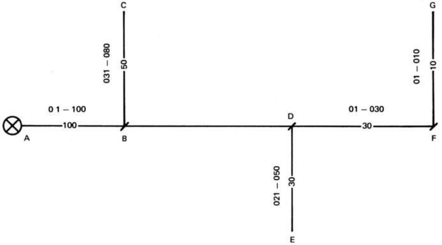
(ii) FAULTY RANGE OF LINES - Particularly useful information for the prompt localization of a MULTIPLE LINE FAULT can be derived from an examination of the relevant plan(s).

For example, if in the subscribers' distribution cable illustrated on page FB-3 the 0 pairs 2-10 are found faulty, the fault can only be in sections:

AB BD DF and FG

TYPICAL FAULT LOCALIZING PROCEDURE (Continued)

and it is probable that the fault is in Section FG.



SIMPLIFIED SUBSCRIBERS' DISTRIBUTION PLAN

TYPICAL FAULT LOCALIZING PROCEDURE (Continued)

(iii) CHOOSING FAULTY LINE(S) - Wherever possible, choose from the number of faulty lines a FAULTY LINE with the most pronounced and easy to locate fault condition, e.g., a S/C or Eth. fault using a Bridge/Varley Locator is easier to locate than an O/C fault. Where the fault resistance is high, faulty conductors may be bunched together to give a stable reading.

(iv) LOCALIZATION OF FAULT BY SECTIONALIZATION OF LINES PLANT - Open the leg(s) of a FAULTY LINE(S) at Terminal Box, Pillar, Cabinet or MDF and prove in which direction the fault lies until the faulty section is isolated.
CABLE JOINTS, INCLUDING OPENABLE JOINTS, SHOULD BE DISTURBED ONLY AS A LAST RESORT. TAKE FULL ADVANTAGE OF THE USE OF INSTRUMENTS FOR FAULT LOCALIZATION.

The details of testing procedures associated with the localization of MULTIPLE LINE FAULTS by testing the chosen FAULTY LINE(S) are described in the following sections of LINEMENS HANDBOOK, LINES TESTING AND INSTRUMENTS:

Section GA, USE OF LINES TEST SET NO. 1,
Section N, USE OF TEST HANDSET (BUTTINSKI),
Section JB, USE OF BRIDGE MEGGER - HAND OPERATED - 500 VOLT,
Section JC, USE OF BRIDGE MEGGER - TRANSISTORISED - 500 VOLT,
Section JA, USE OF AMPOS EQUIPMENT,
Section JD, USE OF PULSE ECHO TESTER ON COAXIAL AND PAIR CABLES.

(v) LOCAL ENQUIRIES AND INSPECTION OF AFFECTED LOCALITY - Observation and local enquiries (for examples of items to look for which could be the cause of a MULTIPLE LINE FAULT see page E-5 of this HANDBOOK) are vital components of fault localization work and are often the easiest ways to quickly localize a fault.

TYPICAL FAULT LOCALIZING PROCEDURE (Continued)

(vi) PRECISE LOCATION OF THE FAULT - Once the faulty section of the lines plant has been isolated the fault is accurately located (see NOTE below) within this section, as outlined in Table 1 (See pages FA-4 to FA-11 inclusive of this HANDBOOK).

NOTE: All testing procedures referred to in the above mentioned Table are described in detail in LINEMENS HANDBOOK, LINES TESTING AND INSTRUMENTS, and are normally applied to the chosen FAULTY LINE(S) (see paragraph (iii) on page FB-4 of this HANDBOOK).

TO AVOID ACCIDENTS WHEN LIFTING MATERIAL OR EQUIPMENT:

(i) USE MECHANICAL EQUIPMENT FOR HEAVY LIFTS,
(ii) DON'T ATTEMPT TO LIFT WEIGHTS BEYOND YOUR CAPACITY,
(iii) USE CORRECT METHODS OF LIFTING AND CARRYING.

LOCALIZATION OF COAXIAL CABLE FAULTS

Issue 1, 1976

LOCALIZATION OF COAXIAL CABLE FAULTS

GENERAL

The fundamental component of a coaxial cable is the coaxial tube which consists of a center copper conductor coaxially placed in a tube (outer conductor) formed from soft copper and separated from it by plastic spacing discs. The outer conductor is held in position by two helical lappings of steel tape followed by helical lappings of paper tape. Some coaxial cables also contain interstice, layer or core pairs.

The techniques used to localize coaxial cable faults depend on a number of factors which include:

(i) The type of fault,

(ii) Whether tests are to be made on coaxial cable tube(s) or on interstice, layer or core pair(s),

(iii) The test equipment most readily available,

(iv) Availability of power to operate test equipment,

(v) Experience and skill of the officer engaged on fault localization work.

The general principles of localizing LINE FAULTS are given in Section E of this HANDBOOK. For localization of faults in interstice, layer or core pairs see Sections FA and FB of this HANDBOOK. Some coaxial cable faults require specialist attention and instruments, which may be provided by the Transmission Measurements and in some States by the Cable Protection Sections.

GENERAL (Continued)

Before starting work, disconnect all power in excess of 20 Volts A.C. r.m.s. or 120 Volts D.C. in the cable. Power feed systems with higher voltages do not need to be disconnected provided they are current limited to 10 MA A.C. r.m.s. or 60 MA D.C. Work may proceed however, on the cable sheath or layer pairs without removing the power from the tubes, core or interstice conductors providing:

(i) Approval has been obtained from the District or Section Office,

and

(ii) The paper core wrappings surrounding the assembly of the tubes, core and interstice conductors are not disturbed,

and

(iii) The Jointer does not work alone.

For safety precautions associated with opening cables carrying power feed circuits refer to E.I. LINES Cables SP5900.

TYPICAL COAXIAL TUBE FAULTS AND THEIR LOCALIZATION

(i) SHORT CIRCUIT BETWEEN INNER AND OUTER CONDUCTORS - A short circuited coaxial tube is not only unable to transmit the carrier signal but it also causes the remote power feed to "throw out" in those repeater sections over which power is fed to dependent minor repeaters.

TYPICAL COAXIAL TUBE FAULTS AND THEIR LOCALIZATION (Continued)

This type of fault can be localized within a repeater section using the following methods described in detail in LINEMENS HANDBOOK, LINES TESTING AND INSTRUMENTS:

(a) Varley Test, pages JB-21 and 22 (Hand Operated Megger) or pages JC-10 to 14 inclusive (Transistorised Megger),

(b) Pulse Echo Technique, Section JD.

Because of the low resistance per unit length of coaxial tube the accuracy of above methods of fault localization is sufficient only if the cause of the fault is visible from a route inspection. Since coaxial cables are buried at considerable depth, the precise fault location in situations where the cause of the fault is not visible from a route inspection will usually be made by the Transmission Measurements or Cable Protection staff, the related testing techniques being beyond the scope of this HANDBOOK.

The cable should not be excavated or disturbed in the vicinity of the fault until this latter precise location has been made, because movement of the cable may remove the SHORT CIRCUIT fault and leave a HIGH VOLTAGE BREAKDOWN fault which is much more difficult to locate precisely.

TYPICAL COAXIAL CABLE FAULTS AND THEIR LOCALIZATION (Continued)

After making the precise location of the fault, expose the cable. The cause of the fault would often be visible on the exterior of the exposed cable and the sheath should then be removed for repair work (see Section GD of this HANDBOOK). A common cause of isolated inner/outer S/C fault is lightning discharge to armoured coaxial cable. If the cause of the fault is not visible, remove the sheath at the point of precise fault location, because the fault most likely will be close enough to be found within a normal sheath opening.

(ii) OPEN CIRCUIT - The most likely cause of an OPEN CIRCUIT fault involving several coaxial tubes is mechanical damage which will be easily visible from a route inspection.

In the case of an OPEN CIRCUIT fault involving only one coaxial tube due, most likely, to a joint becoming open circuit, localize the fault within a repeater section using the following methods described in detail in LINEMENS HANDBOOK, LINES TESTING AND INSTRUMENTS:

(a) Pulse Echo Technique, Section JD,
(b) Locating Disconnexion Technique, pages JC-14 to 18 inclusive.

HIGH VOLTAGE BREAKDOWN

A HIGH VOLTAGE BREAKDOWN between the inner and outer conductors of a coaxial tube will interrupt the service if it occurs in a repeater section over which power is fed to dependent minor repeaters by causing the remote power feed to "throw out".

TYPICAL COAXIAL CABLE FAULTS AND THEIR LOCALIZATION (Continued)

Localize the fault within a repeater section by using The High Voltage Bridge (Western Electric 90A Test Set or equivalent). It should be noted that efficient location of HIGH VOLTAGE BREAKDOWN faults by means of this instrument requires its operation by an experienced operator, who can be provided by Transmission Measurements or Cable Protection Sections in Metropolitan areas. In Country areas this work is normally carried out by specialist officers.

As with a SHORT CIRCUIT fault, precise fault location will be obtained only by taking measurements from the joints on either side of the approximate fault location. The cable should not be excavated or disturbed in the vicinity of the fault until the most accurate fault location possible has been made.

IMPEDANCE IRREGULARITY

Localization of this fault requires the use of a high precision pulse echo locator (HOWALDTSWERKE - DEUTSCHE WERFT Model T05/9 or equivalent). This instrument, together with the services of an experienced operator, can be provided by Transmission Measurements or Cable Protection Sections.

Methods of localization of coaxial tube faults are described in Section 5 of E.I. LINES Cables T2431.

REPAIRING FAULTY LINES PLANT

DO NOT ENTER A MANHOLE WHERE DANGEROUS GAS HAS BEEN DETECTED UNTIL THE GAS HAS BEEN PROPERLY CLEARED. ENSURE THAT A CONTINUOUS MONITORING COMBUSTIBLE GAS DETECTOR IS AVAILABLE. IF NOT RETEST FOR GAS AT LEAST EVERY HOUR.

REPAIRING FAULTY LINES PLANT

GENERAL

The success of a telephone call depends on the reliable operation and proper interworking of telephone instrument, lines plant and exchange equipment connected in a complicated network extending throughout the entire country.

The standard of service provided by this network is often judged by its freedom from faults, but the physical size and widespread location of the Commission's lines plant are alone sufficient to prevent the installation of a "fault-free" system.

It is therefore important that, in maintaining a high standard of service, prompt and efficient attention is given to the restoration of faulty lines plant to normal conditions.

The lines plant service restoration work generally consists of repairing a faulty item of plant at the point of fault or replacing a faulty item of plant. This work is at times preceded by restoration of service(s) on a temporary basis.

The Faultman should be alert to ascertain the primary cause of a fault and either remove the cause or take appropriate action to have it removed, e.g., S/C fault in an uninsulated Open Wire Line caused by movement of poles due to loose stays requires not only removal of the S/C fault but also the tightening of stay wires.

INCIPIENT FAULTS

An INCIPIENT FAULT in LINES PLANT is a non-service affecting condition which, if not corrected, will result in a fault leading to degradation or loss of service.

During the course of their normal duties all lines staff should keep a look out for any INCIPIENT FAULT conditions, for example:

Flying Insulator,
Loose Stay Wire,
Broken Pit Cover,
Damaged Terminating Equipment,
Broken Tie Wire.

If such a condition is detected by a member of lines staff it should be corrected. Where an INCIPIENT FAULT condition can not be corrected by the officer who observed it, the observed condition must be entered into Form E71 (ATTENTION REQUIRED TO DEPARTMENTAL CONSTRUCTION) (see Fig. 1). The original of this form is to be forwarded to the Lines Supervisor who will arrange to have the necessary corrective work carried out.

INCIPIENT FAULTS (Continued)

ORIGINAL POSTMASTER-GENERAL'S DEPARTMENT E 71 (Feb 74)

ATTENTION REQUIRED TO DEPARTMENTAL CONSTRUCTION

LINES SUPERVISOR ....

I have observed the following conditions requiring attention to Departmental construction at the location/s indicated below:

LOCATION (Pole No. and Route, manhole, D.A., etc.)	CONDITION OBSERVED

Reporting Officer .... / /

Designation ....

.... instructed to attend.
(Name and Designation of Fieldsman/Lines Supervisor Gr. 1)

.... / /
LINES SUPERVISOR

SUPERVISING ENGINEER..................................

The condition reported above has / has not been attended to.

Special Remarks..................................

LINES SUPERVISOR.................................. / /

C/R C46306/74-N

FIG. 1 : FORM E71 - ATTENTION REQUIRED TO DEPARTMENTAL CONSTRUCTION

RESTORING FAULTY SERVICE(S)

When a telephone service is 0.0.0. (out of order) due to faulty lines plant its restoration is of paramount importance. The action required to restore the service(s) will depend, however, on the extent of the fault, its location, the type of circuits(s) affected, etc., and will be either:

(i) TEMPORARY - e.g., the service is made usable while permanent restoration work is being completed,

or

(ii) PERMANENT - e.g., service is fully restored and no further interruptions due to lines plant repair work are anticipated.

TEMPORARY RESTORATION OF SERVICE(S)

Temporary restoration of service may be necessary while the lines plant fault is being precisely located or, after the fault has been located, while repair work is being carried out to clear the fault.

In general, the decision to temporarily restore the service(s) will depend on the type of circuit(s) affected, the estimated time that may elapse before the fault is located and cleared as well as the practicability of providing a temporary service. The following three methods of temporary restoration of service(s) are used:

(i) HOSPITAL CIRCUIT - This circuit (see its simplified version in Fig. 2) makes the faulty line usable by converting it to a single wire earth return circuit.

TEMPORARY RESTORATION OF SERVICE(S) (Continued)

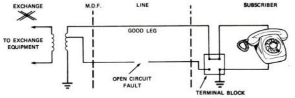


FIG. 2 : USE OF HOSPITAL CIRCUIT ON O/C FAULT

It may be used to provide temporary service for customers whose telephones would otherwise be out of order due to one of the following fault conditions:

* (a) O/C one leg,
(b) Eth. or Gnd. on one leg,
(c) S/C.
(d) F/B
*

In addition to the special equipment provided at the exchange, alterations to the external line circuit will be necessary to enable the temporary service to function. These alterations can be made at a suitable "breaking" point, such as the Terminal Block, Terminal Box, Pillar or Cabinet situated between the site of the fault and the customer's telephone. At the selected terminal the faulty leg is opened and the telephone side of it is connected to earth in the case of O/C or Eth. fault. If the faulty line is S/C, open one leg on the telephone side of the fault and connect it to earth.

TEMPORARY RESTORATION OF SERVICE(S) (Continued)

(ii) INTERRUPTION CABLE - When the faulty section of external plant is localized temporary service can be restored to many customers by running out a length of cable along the faulty section and transferring the working circuits from the faulty section to this cable. Special lengths of cables (slavey cables) on drums for use in such situations may be available. When interruption cable is not available a length of insulated cable can be used to restore service.

(iii) DISCONNECTION OF MULTIPLE POINTS - Due to multiple jointing, there are instances where a fault in one multiple of a line will be responsible for an out of order condition of a telephone service connected to another multiple of the same line. In such a case the service can be temporarily restored by disconnection of a faulty multiple line from the line connecting the customer.

(iv) USE OF MOISTURE DISPERSING AGENTS ON TERMINATING EQUIPMENT - This material (CRC2-26 or equivalent) is effective for removal of moisture from terminating equipment in emergencies, but it should not be used for ordinary repair work which includes:

- (i) Drying the equipment with hot air,
- (ii) Progressive replacement of obsolete equipment,
- (iii) Removing sealing defects in the equipment.

PERMANENT RESTORATION OF SERVICE(S)

Permanent restoration of faulty service(s) caused by fault(s) in line plant can be achieved by:

(i) Repairing a faulty item of lines plant at the site of the fault,
(ii) Replacing a faulty item of lines plant,
(iii) Transferring the affected service to another line.

The details of repair and replacement techniques for various types of lines plant are given in subsequent Sections GA to GJ of this HANDBOOK.

TRANSFERRING A LINE

This method of permanent restoration of a service is usually applied in the case of isolated faulty cable pairs where:

(i) It is not economical to locate and repair the fault,
(ii) The fault condition is not expected to deteriorate and involve other pairs,
(iii) Vacant pair is available.

An example of a situation where transferring a pair would be appropriate is an isolated O/C fault in length of a multi-pair cable.

When a line is to be transferred to restore service:

(i) Ring the Cable Assigner for allocation of a new pair and obtain a sequence number.

PERMANENT RESTORATION OF SERVICE(S) (Continued)

(ii) Transfer the service from the old to the new pair at an appropriate terminating point (cabinet, pillar, etc.) Do this in conjunction with the exchange technical staff if a change of main pair is involved.

(iii) Arrange FAULT CLEARANCE TESTING as outlined on page G-11.

(iv) Prepare Form E95 (see Fig. 3) giving details of pair(s) transferred, type(s) of fault(s) and any information available regarding the location of the fault(s) and forward it to the Lines Supervisor for checking.

(v) The original and duplicate copies of Form E95 are then despatched to Cable Assigner and T.T.O. In-Charge of the Exchange/F.D.C. concerned.

The above described procedure must be followed, whether the transfer affects main, branch or distribution pairs, to enable the pair records to be altered.

If the fault occurs at a time when the Cable Assigner is not on duty, or in the case of isolated country districts when it is not practicable to contact the Cable Assigner, the transfer may be made to a suitable available pair(s), and the Cable Assigner advised as soon as possible.

ALWAYS WEAR A SAFETY BELT AND TAKE A SAFETY LINE WHEN YOU CLIMB A POLE.

PERMANENT RESTORATION OF SERVICE(S) (Continued)

Original POSTMASTER-GENERAL'S DEPARTMENT E95 (LR8)

CABLE PAIR TRANSFER ADVICE

AREA LINE FOREMAN..........

Please arrange to transfer the following services as indicated

Sch. C. 6107/70 .... Exchange

	DIST. AREA	MAIN CABLE		CABINET		PILLAR		CABLE TERMINAL BOX	SUBSCRIBER	
		Code	Pair	Desig-nation	'B' Pair	Desig-nation	'O' Pair		No.	Address
FROM										
TO										
FROM										
TO										
FROM										
TO										

CABLE RECORDER

The transfers have been completed as above and local records amended.

.... Lineman

..../..../19....

CHIEF DRAFTING OFFICER

The transfers have been completed as above and local records amended.

.... Cable Recorder

..../..../19....

FIG. 3 : FORM E95 - CABLE PAIR TRANSFER ADVICE

REPAIR WORK COMPLETION PROCEDURES

When service(s) have been restored permanently, the following procedures must be carried out, as appropriate, to complete the repair work.

REPAIR WORK COMPLETION PROCEDURES (Continued)

FAULT CLEARANCE TESTING

Use the Auto Test Desk facilities to test the line(s). If these facilities are not available, or where according to Local Instructions an "O.K." test from the test desk must be obtained, contact the test desk and request that the line(s) be tested and a "Test O.K." sequence number be given.

"CLOSING DOWN" PROCEDURE

If repair work has been carried out in a manhole or jointing pit, check that:

- the jointing chamber is clean,
- all cables are properly housed and supported,
- all lead sheathed cables are protected at duct entrance and cable bearers by plastic slippers or scrap lead,
- the lids are replaced correctly and do not rock.

If excavating has been necessary to gain access to the cable in the duct, repair or replace broken conduit(s) and fill in the excavation taking care to firmly compact the soil. Where aerial work was involved, do not leave scraps of wire on the ground.

REPAIR WORK COMPLETION PROCEDURES (Continued)

"CLERICAL" PROCEDURE

Complete or supply the following:

(i) In all instances the lineman clearing the fault is responsible for the preparation of the relevant fault docket (see page I-3 of this HANDBOOK) or for passing on the fault details to the fault center.

(ii) If the cable fault was due to corrosion of the sheath, fill in Form E9 (see Fig. 4). This Form should also be filled in if the cause of the sheath failure is doubtful or unusual.

(iii) If the cable or conduit record plans will be affected by the alterations made to the existing construction, prepare a sketch plan (Form E88, see Fig. 5) showing the details of the alterations made.

(iv) Fill in a Form E207 (see Fig. 6) to return scrap copper wire, lead or cable recovered from the job to the store, or where the faulty item of plant was "left in situ", e.g., replaced but not recovered.

(v) If reinstatement of sealed footpath or roadway surfaces are required after repair work, list details of location measurements and type of surface to be reinstated and forward to Lines Supervisor.

BEFORE REPLACING JOINTING PIT COVER CLEAR ANY DIRT FROM AROUND THE TOP OF THE PIT, SO THAT THE COVER SEATS CORRECTLY AND DOES NOT PRESENT A HAZARD TO OTHER PEOPLE.

REPAIR WORK COMPLETION PROCEDURES (Continued)

P.M.G.'S DEPT E9 (Feb. '74)

CABLE CORROSION REPORT

(Also to be used for any unusual fault)

Attach Sample

Section

Exchange

Fault Sequence No. | Alfa Cause Code

Date Reported / / | Cable No. | D.A. No.

Location—*Street, House No., Ref. Pt., Grid etc.*

CABLE SIZE	CLASS OF CABLE
Pairs	☐ Lead-in
lb Conductors	☐ Minor
Co-ax Tubes	☐ Major
	☐ Trunk

SHEATHING

METAL	PLASTIC	COMPOSITE
☐ Lead	☐ Plastic	☐ Moisture Barrier
☐ Aluminium	☐ Nylon	☐ Plas/Metal/Plas
☐ Weld-Steel		
☐ Other	☐ Other	☐ Other

PROTECTION

☐ Armoured ☐ Plastic Jacket

☐ Unarmoured ☐ Nylon Jacket

TYPE OF CONSTRUCTION

☐ In Aerial Cable	☐ In Conduit E.W.
☐ In Chase	☐ In Conduit A.C.
☐ In Tunnel or Well	☐ In Conduit Concrete
☐ In Manhole	☐ In Conduit Metal
☐ In Pit	☐ In Conduit Plastic
☐ On Pole	☐ In Conduit—other type
	In Plastic Pipe under 50 mm
☐ On Wall	☐ *White Plastic*
☐ Under Stream etc.	☐ *Black Plastic*
☐ In Solid	☐ In Iron Pipe under 50 mm

CAUSE OF FAULT

☐ Electrolysis ☐ Pests ☐ Unknown

☐ Chemical Corrosion ☐ Other

NATURE OF LOCALITY, SOIL, ETC.

Repair Action Taken

Remarks

Faultman / /

Lines Supervisor / /

OFFICE USE ONLY | Approx. Cost of Repairs $

SchC7876/74

FRONT VIEW REAR VIEW

FIG. 4 : FORM E9 - CABLE CORROSION REPORT

REPAIR WORK COMPLETION PROCEDURES (Continued)

ORIGINAL
Authority or T/O. No.
Exchange Area

POSTMASTER-GENERAL'S DEPARTMENT

TELEPHONE ORDER AND MINOR WORKS SKETCH PLAN

* PREPARED FROM OFFICE RECORDS ONLY
PREPARED AFTER FIELD INSPECTION

Main Cable No.
Distribution Area

E88 (L. R. 1)
(Pin in this corner)

NOTES.

1. If the actual work done differs from the original sketch the officer performing the work must amend this copy of the sketch accordingly.
* 2. Cross out whichever one does not apply.

L.E.I. GENERAL (L6041 & L6042)

Completed Copy seen by:	Initials	Date
Area Foreman		
Officer amending depot plans		
Line Inspector (when associated with S.E. 577)		
Cable Recorder		
Officer amending divisional office plans		

Estimated / /
Approved / / Divisional Engineer
Work completed and plan checked / /

SCH C 6107/70

FIG. 5 : FORM E88 - TELEPHONE ORDER AND MINOR WORK SKETCH PLAN

REPAIR WORK COMPLETION PROCEDURES (Continued)

Postmaster-General's Department E207 (W.P.97) ORIGINAL

Surplus and/or Recovered MATERIAL RETURNED to an ENGINEERS' STORE or MATERIAL DESTROYED or LEFT IN SITU

To Engineers' Store with Material receipted by O.I.C. Engrs' Store, and forwarded to Costing Section

№ 17201

Per...

CARTAGE DOCKET No. (IF ANY)...

Serial No.	Item No.	Description of Material as shown in Stock List	Reason for Return †	Fit or Unfit §	Quantity	Rate		Costing Section Amount		Entered on Bin Tally Card No.
Despatching Officer Date		Received the above material Date						$		CODED

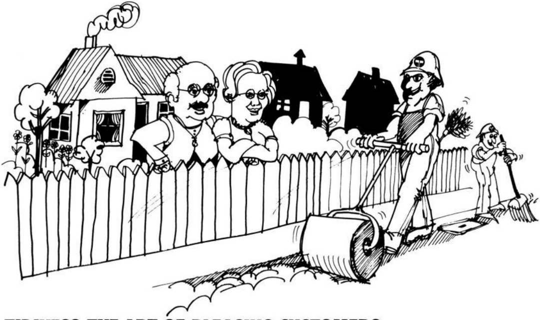
* Use separate form for each Authority or Plant Account.
† Insert 'S' for surplus; 'C' for Recovered or Dismantled; 'D' for Destroyed; 'L' for Left in situ.
§ "F" for Fit; "U" for Unfit.

Entered on Material Sheet

FROM–	Title of Work	Locality	Sect. ref. / / Authority/Plant A/c. *	CR.
TO–	Engineers' Store at		Sect. ref. / / ENGINEERS' STORE/Plant A/c.	DR.

Sch. C. 7758/73

FIG. 6 : FORM E207 - SURPLUS AND/OR RECOVERED MATERIAL RETURNED TO AN ENGINEERS' STORE OR MATERIAL DESTROYED OR LEFT IN SITU



TIDINESS-THE ART OF PLEASING CUSTOMERS

Issue 1, 1976

REPAIRING LEAD SHEATHED PAPER INSULATED CABLE

WHEN EXCAVATING BEWARE OF POWER CABLES.

Issue 1, 1976

REPAIRING LEAD SHEATHED PAPER INSULATED CABLE

GENERAL

The major causes of faults in LEAD SHEATHED PAPER INSULATED CABLES are:

In Length	In Joint
Mechanical Damage,	Faulty Lead Wipe,
Corrosion,	Insulation Failure (Shiners).
Sheath Fatigue.	

For general procedures associated with repairing faulty lines plant, including:

(i) Temporary restoration of service(s),
(ii) Permanent restoration of service by transferring a line
and
(iii) Repair work completion procedures

see Section G of this HANDBOOK.

For precautions associated with OPENING WORKING CABLES and with MINIMISING INTERRUPTIONS TO WORKING CIRCUITS see Section C of this HANDBOOK.

REPAIRING FAULTY CABLE AT SITE OF FAULT

DRYING OUT WET CABLE

Where the damage to the cable is such that it is necessary to dry out the cable to restore services, remove the sheathing from the wet section of cable until at least 80 mm of dry conductors are exposed.

REPAIRING FAULTY CABLE AT SITE OF FAULT (Continued)

Cut away whippings and carefully separate conductors and dry out paper insulation with hot dry air.

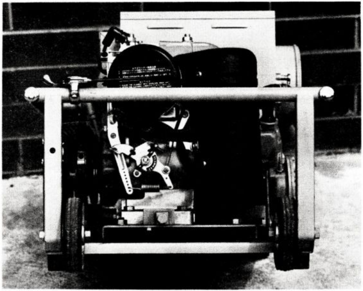
Portable 240 Volt Alternator - Ventilator - Heater, Telial Model B5 (see illustration on page GA-4 and APO EI LINES General MA 4000) or hot air dryers of various types and sizes purchased locally may be used to dry out paper insulation. Where a hot air dryer is not available, use a sheet of iron heated by a plumber's torch (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1).

Wet paper insulation can be fully restored by drying, provided the links at the exchange have been removed from faulty lines early enough to prevent charring arising from heating at the fault due to presence of exchange battery. Therefore, after paper insulation has been completely dried out, roll it between the thumb and forefinger to check the extent of charring. Small areas of charred insulation can be repaired with split paper sleeve or adhesive cellulose tape; if charring is extensive, piece out the affected wires.

If salt deposits have caused severe discolouration of the insulation, piece out the wires as the insulation resistance of extensively discoloured paper will be reduced.

WHEN USING A PRICKER, TAKE CARE NOT TO DAMAGE THE PAPER INSULATION MORE THAN NECESSARY. DO NOT USE PRICKER WITH PLASTIC CABLE.

REPAIRING FAULTY CABLE AT SITE OF FAULT (Continued)



PORTABLE 240 VOLT ALTERNATOR - VENTILATOR - HEATER, TELIAL MODEL B5

REPAIRING FAULTY CABLE AT SITE OF FAULT (Continued)

REPAIRING FAULTY CABLE IN LENGTH

Where a cable fault occurs in length due to mechanical damage and the signs of damage are evident, or where an accurate fault location is made, the quickest and cheapest method of service restoration is, if the cable is laid directly in the ground, to dig down to the fault and repair the cable. Where the cable is in a conduit it may be more economical to withdraw and replace a length between two jointing chambers, rather than to dig down to the fault, even if the conduit containing the cable is in an accessible position. Individual assessment of each case should be made. Where it has been decided to dig down to the fault the steps to follow are:

(i) Excavate at the site of the fault taking care not to cause additional damage to the cable, until the cable or conduit is exposed.

(ii) If the cable is in conduit, break the conduit carefully to avoid damage to the cable and bearing in mind the need to repair the conduit later.

(iii) If the failure point in the sheath is not obvious or the sheath is not warm at the point indicated by the location test, apply air pressure to the cable at a nearby joint and soap the cable sheath in the suspected area to detect the hole.

(iv) With the position of the fault known, enlarge the excavation to facilitate the repair work and deep enough to act as a sump in the event of water collecting in the excavation.

IMMEDIATELY WORK HAS BEEN COMPLETED, ARRANGE FOR GASSED CABLE TO BE RECHARGED WITH DRY AIR.

REPAIRING FAULTY CABLE AT SITE OF FAULT (Continued)

(v) REPAIRING MINOR DAMAGE - Repair small holes or cracks in the cable sheathing with wiping metal after making sure that the conductor insulation has not been damaged. If water is in the vicinity of damage to cable it may be necessary to open hole(s) or crack(s) with hammer and hack knife and inspect the paper wrappings for dampness. If the paper wrappings are found to be damp, dry out the cable as explained on page GA-2 before sealing it.

(vi) REPAIRING MAJOR DAMAGE - After drying out the cable (if necessary) cover the hole with a plumbed sleeve. Where it is necessary to remove a section of plastic jacket from the sheath to effect repairs, replace the jacket, after sealing the sheath, by fitting a Wraparound Repair Sleeve (see Section H of this HANDBOOK) over the opening in the plastic jacket and overlapping the jacket by 75 mm at each end.

REPAIRING FAULTY JOINT

(i) REPAIRING MINOR DAMAGE - Repair small holes or cracks in the lead sleeve with wiping metal after making sure that the conductor insulation has not been damaged.

REPAIRING FAULTY CABLE AT SITE OF FAULT (Continued)

(ii) REMOVING LEAD SLEEVE FROM WET JOINT - When moisture has entered into a joint it is necessary to open the joint to gain access to the wet insulation. Do this as follows:

(a) Do not attempt to remove the plumbed lead sleeve by applying heat to melt the wiping metal as the steam pressure generated within the joint may spray molten metal in a dangerous manner. Take particular care where some gas pressure remains in the cable.

(b) Cut around the circumference of the sleeve at each end with a hack knife leaving the wiped bases intact. Then cut along the sleeve to remove it from the joint. This will avoid the danger of spraying metal and also prevent further wetting of paper insulation by steam.

(c) If moisture is present at the end of the joint, use heat to remove the wiped bases and then cut back sheathing until dry insulation is obtained.

(d) Dry out and repair the insulation and conductors as described on pages GA-2 and GA-3 of this HANDBOOK.

REPLACING FAULTY CABLE SECTION

It is not always practicable to repair a cable at the site of the fault for various reasons, such as:

(i) The damage to the cable may be too extensive or widespread, as could be the case where cable sheath is damaged by corrosion.

REPLACING FAULTY CABLE SECTION (Continued)

(ii) Access to the fault may be difficult, e.g., where cable is in the center of a multi-duct run.

(iii) The size of a repair joint, if in duct, may prevent future installation of additional cable in the same duct or withdrawal of cable at a future date.

(iv) Localization testing may have failed to determine the fault site even though the faulty length has been isolated.

In such instances the section of cable containing the fault is replaced with new cable. This can be done between two adjacent joints or by creating new joints at suitable positions on each side of the site of the fault. If required for future development in the area the replacement cable can be larger than the faulty cable.

REPAIRING MOISTURE BARRIER CABLE

DO NOT MAKE ALTERATIONS TO WORKING PAIRS OTHER THAN THOSE
SHOWN ON TRANSFER ADVICE WITHOUT OBTAINING PRIOR APPROVAL.

Issue 1, 1976

REPAIRING MOISTURE BARRIER CABLE

GENERAL

MOISTURE BARRIER cable is a paper insulated cable covered with polyethylene sheath to which an aluminium foil is internally banded. The aluminium foil provides:

(i) Inhibition to permeation of moisture,
(ii) Electrostatic shielding.

The major causes of faults in MOISTURE BARRIER CABLE are:

In Length	In Joint
Mechanical Damage.	Faulty Early Epoxy Resin Seals, Insulation Failure (Shiners).

For general procedures associated with repairing faulty lines plant, including:

(i) Temporary restoration of service(s),
(ii) Permanent restoration of service by transferring a line
and
(iii) Repair work completion procedures

see Section G of this HANDBOOK.

For general procedures associated with REPAIRING FAULTY CABLE AT SITE OF FAULT and REPLACING FAULTY CABLE SECTION see Section GA of this HANDBOOK.

For precautions associated with OPENING WORKING CABLES and with MINIMISING INTERRUPTIONS TO WORKING CIRCUITS see Section C of this HANDBOOK.

REPAIRING FAULTY CABLE

REPAIRING MINOR DAMAGE

Repair small holes, e.g., cuts, nail holes, abrasion, termite or ant attack, by fitting a Wraparound Repair Sleeve (see Section H of this HANDBOOK) directly over the cable after checking that conductor insulation has not been damaged.

Where it is necessary to remove a small section of sheath to check for conductor insulation damage the gap should be covered either by the removed piece of sheath or by a piece of sheet lead of a size equivalent to that removed so that the cable diameter is uniform. Connect the aluminium foil across the gap by means of a continuity wire. (See E.I. LINES Cables J3423). Seal the cable with a Wraparound Repair Sleeve (see Section H of this HANDBOOK) allowing an overlap of 150 mm at each end beyond the point to be sealed.

REPAIRING MAJOR DAMAGE

These repairs involve removal of a section of sheath exceeding 300 mm in length to repair conductors or fitting a repair joint.

Where only a few conductors require repairs and the diameter of the cable is not greatly increased wrap several layers of paper around the repaired cable core and fit a lead sleeve (wiped seam) over the opening, overlapping the sheath at each end by 150 mm. Seal each end with a 300 mm length of Wraparound Repair Sleeve (see Section H of this HANDBOOK).

REPAIRING FAULTY CABLE (Continued)

Where extensive conductor repairs or fitting of a repair joint are required prepare the joint as described in E.I. LINES Cables J3420. Split the spun lead bases so that they can be fitted over the cylindrical sections and wipe in position on the cable. Secure each spun lead base with a Wraparound Repair Sleeve (see Section H of this HANDBOOK).

NOTE: In both abovementioned situations connect the aluminium foil across the gap by means of a continuity wire.

PARK MOTOR VEHICLES AND MECHANICAL AIDS WHERE THEY DO NOT OBSTRUCT DRIVEWAYS OR ENTRANCES TO PREMISES.

REPAIRING SMALL SIZE PLASTIC CABLE

GOOD WORKMANSHIP MEANS BETTER SERVICE FOR THE CUSTOMER AND REDUCES THE POSSIBILITY OF SERVICE INTERRUPTIONS.

Issue 1, 1976

REPAIRING SMALL SIZE PLASTIC CABLE

GENERAL

The major causes of faults in SMALL SIZE PLASTIC CABLES are:

In Length	In Joint
Mechanical Damage,	Insulation Failure,
Termites,	Conductor Failure,
Ants,	Defective Encapsulation.
Rodents.	

For general procedures associated with repairing faulty lines plant, including:

(i) Temporary restoration of service(s),

(ii) Permanent restoration of service by transferring a pair and

(iii) Repair work completion procedures

see Section G of this HANDBOOK.

For general procedures associated with REPAIRING FAULTY CABLE AT SITE OF FAULT and REPLACING FAULTY CABLE SECTION see Section GA of this HANDBOOK.

CLEAN UP PROPERLY WHEN THE JOB IS COMPLETE. ENDEAVOUR TO LEAVE THE JOB SITE AT LEAST AS TIDY AS IT WAS BEFORE THE WORK COMMENCED.

REPAIRING FAULTY JOINTS

All types of Joints, other than:

Openable Joints and

Joints on Above Ground Jointing Posts

cannot be repaired and, if faulty, should be replaced, subject to local conditions and instructions.

Of the various available joint replacement techniques outlined below preference should be given to the use of Openable Joints.

PLASTIC TO PLASTIC JOINT WHERE THE CABLE IS DRY

Where on removal of the faulty joint it is found that the cable is dry the replacement joint can be made using one of the following available jointing techniques:

(i) Openable Joint

Install an appropriate type of an Openable Joint (see relevant Sections of LINEMENS HANDBOOK, CABLE JOINTING No. 1).

(ii) Single Ended Encapsulated Joint

Where 100/0.64, 70/0.90 or 100/0.90 cables are involved a Single Ended Encapsulated Joint (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1) may be installed.

REPAIRING FAULTY JOINTS (Continued)

(iii) Above Ground Jointing Post

Alternatively, the repair joint may be accommodated in Above Ground Jointing Post (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1).

PLASTIC TO PLASTIC JOINT WHERE THE CABLE IS MODERATELY WET

Where the cable is damp (core wrapping paper is moist) and the replacement of cable is not desirable due to economical or practical considerations, dry the end(s) of the cable and joint as outlined above for DRY CABLE.

PLASTIC TO PLASTIC JOINT WHERE THE CABLE IS VERY WET

Where the cable is very wet (water exudes from it) and the replacement is not possible immediately (e.g.,the cable is directly buried and a street pipe is not available at the time) dry the end(s) of the cable and joint as outlined above for DRY CABLE. USE MOISTURE ESCAPE VENT when installing an appropriate type of Openable Joint (see relevant Sections of LINEMENS HANDBOOK CABLE JOINTING No. 1 and E.I. LINES Cables J3606).

REPAIRING FAULTY JOINTS (Continued)

PAPER TO PLASTIC JOINT

Where a taped or encapsulated PILC to plastic cable joint is faulty replace it as follows:

(i) Joint a length of about 2 metres of PVIUT Tail Cable to the PILC cable by using ~~conventional soldered twist conductor joints and paper sleeves~~ CONNECTORS. Seal the joint with a plumbed lead sleeve.

(ii) Use an appropriate type of joint as explained above to connect the other end of PVIUT Tail Cable to plastic cable, paying due attention to the condition of the plastic cable with regard to the presence of moisture.

REPAIRING OPENABLE JOINTS

The repair work, which may be required on these joints, includes:

(i) Rejointing broken conductors.

(ii) Repositioning the joint in a pit or manhole to ensure that it is:

(a) In a vertical position and

(b) As near to the top of the jointing chamber as possible.

(iii) Piecing out or rejointing conductors to eliminate insulation damage.

REPAIRING FAULTY JOINTS (Continued)

(iv) Repositioning conductor joints to ensure that they are as high as possible above the base.

A NEW SILICON GREASE FILLED SLEEVE OR A GREASE FILLED CONNECTOR MUST BE USED WHERE A SLEEVE WAS REMOVED FROM A CONDUCTOR JOINT.

REPAIRING FAULT IN LENGTH - CABLE IN PIPE

REPAIRING MINOR DAMAGE

Minor faults in DISTRIBUTION CABLES, e.g., cuts, nail holes or pests attack, where only a few conductors are damaged and water has not entered the cable, may be repaired ~~by means of an epoxy encapsulated joint~~. Dig down to the fault, remove a section of pipe and sheath and piece out the damaged conductors as required and fit a:

Double Ended Jointing ~~Mould~~,
S.433/~~65 (see~~ pages GC- 9 and 10 of this HANDBOOK)
~~or manufacture a~~

Lead Mould Double ~~Ended~~ Repair Joint
(see ~~pages~~ GC- 11 to 15 of this HANDBOOK)

to cover the affected area and fill with epoxy resin. Fit a jointing pit over the repair joint to mark its location and to provide access.

REPAIRING FAULT IN LENGTH - CABLE IN PIPE (Continued)

In the case of a fault in LEAD-IN CABLE withdraw the faulty cable from the pipe and install a new cable in the pipe. Terminate the cable direct in the customer's premises and joint its other end to the distribution cable utilizing the short stub of the existing lead-in cable. In the case of an Openable Joint, it is preferable to utilize the subsidiary nozzle. See pages GC -3 and 4 of this HANDBOOK for the jointing practices appropriate for the various moisture presence conditions of the cable.

REPAIRING MAJOR DAMAGE

Major faults, e.g., extensive damage to sheath and conductors associated with water entry into the cable, necessitate replacement of the entire section of cable between jointing pits or Above Ground Jointing Posts. In such instances withdraw the faulty section of the cable from the pipe, repair the pipe, if required, and install a new cable in the pipe.

Joint the cable as explained on pages GC-3 and 4 of this HANDBOOK, paying due attention to the condition of the cable with regard to the presence of moisture.

REPAIRING FAULT IN LENGTH - CABLE IN SOLID

REPAIRING MINOR DAMAGE

Apply procedure outlined on page GC 6 of this HANDBOOK for REPAIRING MINOR DAMAGE, CABLE IN PIPE, apart from the necessity to remove a section of pipe.

REPAIRING SMALL SIZE PLASTIC CABLE

REPAIRING FAULT IN LENGTH - CABLE IN SOLID (Continued)

In the case of a fault in LEAD-IN CABLE in URBAN AREAS - install a new cable in pipe. In RURAL AREAS - dig down to the fault and replace the damaged part of the cable. Terminate the new cable direct in the customer's premises and joint its other end to the distribution cable utilizing the short stub of the existing lead-in cable. In the case of an Openable Joint, it is preferable to utilize the subsidiary nozzle. See pages GC-3 and 4 of this HANDBOOK for the jointing practices appropriate for the various moisture presence conditions of the cable.

REPAIRING MAJOR DAMAGE IN URBAN AREAS

Major faults, e.g., extensive damage to sheath and conductors associated with water entry into the cable, are, subject to local conditions and instructions, repaired by replacement of the entire section of cable between jointing pits or Above Ground Jointing Posts, the new cable being installed in pipe. Joint the cable as explained on pages GC-3 and 4 of this HANDBOOK, paying due attention to the condition of the cable with regard to the presence of moisture.

REPAIRING MAJOR DAMAGE IN RURAL AREAS

Subject to local conditions and instructions, major faults may be repaired as outlined above for REPAIRING MAJOR DAMAGE IN URBAN AREAS or by replacing only the damaged part of the cable. In this latter case, install the replacement cable in solid and fit a jointing pit over each repair joint to mark its location and to provide access. Joint the cable as explained on pages GC-3 and 4 of this HANDBOOK, paying due attention to the condition of the cable with regard to the presence of moisture.

ALWAYS TAKE A SAFETY LINE WHEN CLIMBING A POLE, IT MAY BE THE MEANS OF SAVING YOUR LIFE.

INSTALLING DOUBLE ENDED REPAIR JOINT

APPLICATION

Plastic Double Ended Jointing Moulds (S.433/65) may be used for repairing MINOR DAMAGE in plastic cables and for water barriers in plastic cables up to 100 pair.

Do not use this joint to repair wet plastic cable.

CONDUCTOR JOINTING

Remove sheath for a joint opening of 100 mm. Joint conductors with 10 mm twist joint soldered at tip. Cover with 25 mm plastic sleeves (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1).

FITTING MOULD

Cut enough off tapered ends of the mould to allow it to fit neatly over the cables at each end of the joint.

INSTALLING DOUBLE ENDED REPAIR JOINT (Continued)

Slit the mould along the top seam so that it can be spread and placed over the joint (see Fig. 1). Cut a hole in the pouring slot.

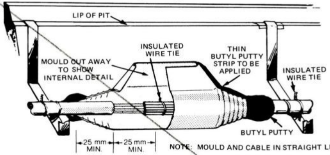


FIG. 1 : INSTALLING DOUBLE ENDED REPAIR JOINT

Where two small cables enter the mould at one end, separate them by a piece of butyl putty inserted about 25 mm back from the sheath ends.

Center mould over the joint making sure that wires do not touch the sides. Secure mould in position with butyl putty around the ends and seal seam with a strip of butyl putty.

Fill mould with epoxy resin.

INSTALLING LEAD MOULD DOUBLE ENDED REPAIR JOINT

APPLICATION

The Encapsulated Lead Mould Double Ended Repair Joint may be used only where it is necessary to repair a buried plastic cable damaged in section. Do not use this joint to repair wet plastic cable or for plastic to PILC cable joints.

CONDUCTOR JOINTING

Piece out any damaged conductors with similar coloured plastic insulated wire using soldered twist joints and plastic sleeves (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1). Do not tie the joint with tape. Wrap the joint loosely with plastic impregnated fibre glass mesh 40 mm wide (S.433/64).

AVOID SCRATCHES FROM OLD COPPER WIRE AS VERDIGRIS ON THE WIRE CAN CAUSE SEVERE BLOOD POISONING. TREAT ANY INJURIES IMMEDIATELY.

INSTALLING LEAD MOULD DOUBLE ENDED REPAIR JOINT (Continued)

PREPARING BUTYL PUTTY COLLARS

Build up 25 mm wide Butyl Putty (S.433/9) collars on the sheath ends with the edges of the collars 25 mm away from the joint opening (see Fig. 2). Build up the collars until a straight edge placed between the collars clears the wrapped joint by 5 mm.

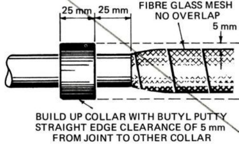


FIG. 2 : PREPARING BUTYL PUTTY COLLARS

INSTALLING LEAD MOULD DOUBLE ENDED REPAIR JOINT (Continued)

PREPARING LEAD MOULD

To determine width of the mould, measure around each collar using a piece of scrap wire and add 15 mm. Make the length of the mould equal to the joint opening plus 75 mm.

Do not clean the surface of the lead. Shape mould around a piece of pipe. Fold flange ends inwards on one side of the mould (see Fig. 3).

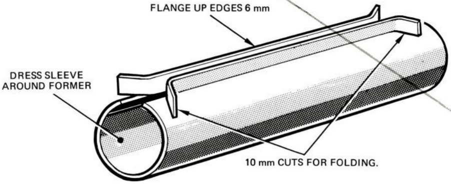


FIG. 3 : MOULD MADE FROM 2 mm SHEET LEAD

INSTALLING LEAD MOULD DOUBLE ENDED REPAIR JOINT (Continued)

FITTING LEAD MOULD

Form the mould around the joint to cover half the width of the butyl putty collars. Position the pouring slot so that it will be uppermost when the joint is placed in its permanent position. Fold and seal the flange ends with butyl putty (see Fig. 4). Seal the ends of the mould with an additional layer of butyl putty.

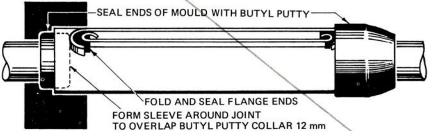


FIG. 4 : FITTING LEAD MOULD

Place joint in its final position in the jointing chamber with the pouring slot upright and level.

INSTALLING LEAD MOULD DOUBLE ENDED REPAIR JOINT (Continued)

To ensure that no leaks have occurred re-apply pressure to the butyl putty end seals.

Mix epoxy resin (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1) and gently squeeze contents of the bottle into the mould. Run the resin to and fro along the full length of the pouring slot and continue until the resin completely fills the lead mould and pouring slot. While pouring try to ensure that the resin trickles down the inside of the mould to help avoid air bubbles. Allow resin to settle for five minutes then top up. A completed joint is illustrated in Fig. 5.

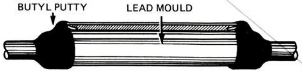


FIG. 5 : COMPLETED JOINT

REPAIRING COAXIAL CABLE

This Section will be issued at a later stage

REPAIRING SINGLE QUAD CARRIER CABLE

WHEN DRIVING TELECOM COMMISSION'S VEHICLES OBSERVE ALL TRAFFIC LAWS AND REGULATIONS. EXTEND THE COURTESY OF THE ROAD TO OTHER DRIVERS.

Issue 1, 1976

REPAIRING SINGLE QUAD CARRIER CABLE

GENERAL

The SINGLE QUAD CARRIER CABLE core consists of four copper conductors, which are insulated with polythene and quadded around a polythene core string. The quad is whipped with a coloured tape. Blue coloured whipping denotes "SEND" and orange coloured whipping - "RECEIVE" type of cable. The cable core is sheathed with polythene, above which a copper tape screen is applied. The whole cable is covered with a black nylon jacket.

The major causes of faults in SINGLE QUAD CARRIER CABLE are:

In Length	In Joint
Mechanical Damage,	Faulty Epoxy Resin Encapsulation.

For general procedures associated with repairing faulty lines plant, including:

(i) Temporary restoration of service
and
(ii) Repair work completion procedures

see Section G of this HANDBOOK.

For general procedures associated with REPAIRING FAULTY CABLE AT SITE OF FAULT and REPLACING FAULTY CABLE SECTION see Section GA of this HANDBOOK.

WHEN WORK IS HELD UP TEMPORARILY AWAITING TRANSPORT OR MATERIAL, DO NOT GIVE THE IMPRESSION OF BEING IDLE. REMEMBER YOU ARE CONSTANTLY UNDER THE OBSERVATION OF THE PUBLIC.

REPAIRING FAULT IN LENGTH

REPAIRING MINOR DAMAGE

Minor faults, e.g., cuts or nail holes, where water has not entered the cable, are repaired by cutting out the small damaged section of the cable and replacing it with the section of the same type ("SEND" or "RECEIVE"). Joint the replacement section using straight joints as explained in E.I. LINES Cables J3800. Fit a jointing pit over the repair joints to mark their location and to provide access.

REPAIRING MAJOR DAMAGE

Major faults, e.g., extensive damage to sheath and conductors associated with water entry, or where a long section of cable is contaminated with water, necessitate replacement of the whole damaged section. Cut out the damaged section of the cable and replace it with the section of the same type ("SEND" or "RECEIVE"). Where a long section of cable is filled with water, open the cable at say 3 metre intervals until dry cable is reached. Replace the water damaged section with the cable of the same type ("SEND" or "RECEIVE") and joint it using straight joints as explained in E.I. LINES Cables J3800. Fit a jointing pit over each repair joint to mark its location and to provide access.

REPAIRING FAULT IN JOINT

Joints of both types, e.g., "fully encapsulated" and "thermo shrink", cannot be repaired and, if faulty, should be replaced using the jointing technique described in E.I. LINES Cables J3800.

REPAIRING TERMINATING EQUIPMENT

PEOPLE WATCH YOU AT YOUR WORK. FILL IN IDLE PERIODS WITH MAINTENANCE WORK ON YOUR TOOLS AND EQUIPMENT AND AVOID UNFAVOURABLE PUBLIC COMMENT.

Issue 1, 1976

REPAIRING TERMINATING EQUIPMENT

GENERAL

TERMINATING EQUIPMENT, e.g., cabinets, pillars, cable boxes, terminal blocks, provides cross-connecting facilities for aerial or underground customers' circuits.

The major causes of faults in the TERMINATING EQUIPMENT are:

Insulation Failure,

Conductor Failure.

For general procedures associated with repairing faulty lines plant, including:

(i) Temporary restoration of service(s),

(ii) Permanent restoration of service by transferring a pair

and

(iii) Repair work completion procedures

see Section G of this HANDBOOK.

ENTRY OF WATER

Ingress of water into TERMINATING EQUIPMENT results initially in L.I.R., S/C and X faults. Unless corrective action is taken promptly, H.R. and O/C faults due to battery action will also occur. The repair work associated with prevention and rectification of damage caused by the entry of water into the TERMINATING EQUIPMENT generally consists of:

(i) Drying the equipment with hot air.

(ii) Cleaning the interior of the equipment with dry cotton waste, cloth or brush.

(iii) Removing sealing defects in unit type terminating equipment, including re-instatement of Schrader valves where these have been removed to facilitate turning of the captive nut.

(iv) Ensuring that covers of terminating equipment are fitted properly.

(v) Replacing rubber seals, where required.

(vi) Progressive replacement of obsolete items of terminating equipment.

Where TERMINATING EQUIPMENT has been subjected to extensive flooding, use may be made of Moisture Dispersing Agents (CRC2-26 or equivalent) to facilitate service restoration work. It should be stressed, however, that these materials may be used only in emergencies.

REPAIRING TERMINATING EQUIPMENT

JUMPER LEADS

Typical causes of faults in JUMPER LEADS are as follows:

(i) Overtension of wire.

(ii) Excessive stripping of wire insulation.

(iii) Damaged wire insulation.

(iv) Corrosion of wire.

Replace faulty jumper leads with the new leads (see relevant Section of LINEMENS HANDBOOK, CABLE JOINTING No. 1) or reterminate if sufficient slack in undamaged jumper lead is available.

TAG TERMINATIONS

Typical causes of faults in TAG TERMINATIONS and the associated repair techniques are as follows:

(i) Dry Joint

(a) Disconnect jumper lead.
(b) Remove excess of solder from the tag, if necessary.
(c) Reterminate jumper lead.
(d) Solder with activated resin cored 65/35 solder (S.4/5).

PLACE MATERIALS AND TOOLS WHERE THEY WILL NOT OBSTRUCT PEDESTRIANS OR VEHICLES.

TAG TERMINATIONS (Continued)

(ii) Excess of Solder on Tag

Heat the tag with soldering iron to the stage where the solder becomes plastic and remove the excess of solder with a small brush.

(iii) Tarnished Tag, Verdigris

(a) Disconnect jumper lead.

(b) Clean the tag. In the case of Unit Type Terminating Equipment (300, 900, 1,800 pair) clean the tag with JUMPER TERMINATING TOOL (S.93/39). In the case of old type terminating equipment scrape the tag with a small flat file and clean with emery cloth.

(c) Reterminate jumper lead, if sufficient length is available. Otherwise install a new jumper lead.

(d) Solder with activated resin cored 65/35 solder (S.4/5).

(iv) Tags Heavily Corroded

Where the tags are heavily corroded replace the terminal unit in the case of Unit Type Terminating Equipment or the whole equipment item in the case of old type Terminating Equipment.

(v) Air Leaks at Tags

Install a gas seal in the cable tail. If monitoring of cable tail shows deterioration of I.R. replace the terminal unit or the whole item of Terminating Equipment.

REPAIRING TERMINATING EQUIPMENT

SCREW TERMINATIONS

Typical causes of faults in SCREW TERMINATIONS and the associated repair techniques are as follows:

NOTE: Where repairs to SCREW TERMINATIONS involve retermination of bridle or drop wire which is too short or which has brittle insulation, replace it.

(i) Unsatisfactory Contact or Broken Conductor

Above conditions cause O/C or H/R faults and, where the termination components are in good condition, are rectified by tightening the screw(s) or by retermination (see relevant Sections of LINEMENS HANDBOOK, CABLE JOINTING No. 1, and LINEMENS HANDBOOK, AERIAL LINES).

(ii) Termination Components Tarnished, Verdigris

(a) Disconnect conductors by dismantling nuts and washers.

(b) Clean the base, nuts and washers with emery cloth (do not use emery cloth on galvanized screws).

(c) Fit new nuts and washers, if necessary.

(d) Reterminate (see relevant Sections of LINEMENS HANDBOOK, CABLE JOINTING No. 1, and LINEMENS HANDBOOK, AERIAL LINES).

(iii) Termination Components Heavily Corroded

Replace the strip or the whole item of Terminating Equipment.

INTERIOR FACE(S)

Presence of corrosion products (verdigris), spiderwebs, etc. on the interior face(s) of Terminating Equipment causes S/C, X, Eth., L.I.R., or FB faults. To rectify this condition, clean the interior face(s) of Terminating Equipment with dry cotton waste, cloth or brush.

REPAIRING AERIAL CABLE AND DROP WIRE

This Section will be issued at a later stage

REPAIRING OPEN-WIRE LINES

TREAT ALL POWER WIRES AND FITTINGS ON POWER POLES AS "LIVE" AND DANGEROUS.

Issue 1, 1976

REPAIRING OPEN-WIRE LINES

GENERAL

The major causes of faults in OPEN-WIRE LINES are:

Trees and Undergrowth,
External Causes,
Wire Regulation,
Fatigue.

For general procedures associated with repairing faulty lines plant, including:

(i) Temporary restoration of service(s),

(ii) Permanent restoration of service by transferring a line

and

(iii) Repair work completion procedures

see Section G of this HANDBOOK.

INCIPIENT FAULTS

An incipient fault in OPEN-WIRE LINES is a non-service affecting condition which, if not corrected, will result in a fault leading to degradation or loss of service.

ADJUST AND LUBRICATE TOOLS REGULARLY.

INCIPIENT FAULTS (Continued)

During the course of their normal duties all lines staff should keep a look-out for any INCIPIENT FAULTS. If such a condition is detected by a member of lines staff, it should be corrected as outlined in Table 1.

INCIPIENT FAULT CONDITION	REQUIRED CORRECTIVE ACTION
Insulator spindle - broken.	Replace spindle.
Insulator - broken or cracked.	Replace insulator.
Insulator on spindle - flying.	Install toggle.
Insulator - loose on spindle.	Replace spindle.
Line wire(s) - excessive sag.	Re-regulate.
Tie wire - broken.	Renew tie wire.
Pole cap - loose.	Renail.
Arm - split, broken or decayed.	Replace arm.
Arms, braces or combiners - loose.	Tighten or replace bolts and/or coach screws.
Transposition fittings - loose.	Tighten bolts.
Stay wire - loose.	Adjust the stay.
Stay rod - corroded.	Replace stay rod.

TABLE 1 TYPICAL INCIPIENT FAULTS (Continued next page)

INCIPIENT FAULTS (Continued)

INCIPIENT FAULT CONDITION	REQUIRED CORRECTIVE ACTION
Birds nests, spider webs.	Remove.
Tree, undergrowth touching line.	Lop the tree, undergrowth.
Soil erosion around pole.	Fill and ram the earth around pole.
Termite or ant attack on pole.	Excavate around the pole to the depth of about 300 mm and pour 10 litres of creosote into the excavation. Fill with earth and ram.
Pole turned.	Untie line wires, turn the pole with canthook to correct position. Retie line wires and adjust stay tension, if necessary.
Pole leaning.	Support the pole by pikes. Untie line wires, dig down on the side opposite to the lean and upright the pole using B-pike and the lifting jack. Fill and ram the earth around pole. Retie line wires and adjust stay tension, if necessary.

TABLE 1 : TYPICAL INCIPIENT FAULTS

INCIPIENT FAULTS (Continued)

Where an INCIPIENT FAULT condition can not be corrected by the officer who observed it, the observed condition must be entered into Form E71 (ATTENTION REQUIRED TO DEPARTMENTAL CONSTRUCTION) (see page G-4 of this HANDBOOK). The original of this form is to be forwarded to the Lines Supervisor who will arrange to have the necessary corrective work carried out.

CLEARANCE OF FAULTS

When a fault has been localized (see Sections FA and FB of this HANDBOOK) it is cleared as quickly as possible. In addition, steps must be taken to ensure that the fault will not return, which could happen if the unstandard condition of the line, which may have caused the fault, is not rectified. It is important therefore to examine the line in each individual case and to either rectify any unstandard condition found or to complete Form E71 (see page G-4 of this HANDBOOK) and forward its original to the Lines Supervisor.

Typical OPEN-WIRE faults, causes and the associated fault-clearance activities are outlined in Table 2.

CARELESSLY HANDLED WIRE END CAN BE DANGEROUS AND COULD COST SOMEONE AN EYE.

CLEARANCE OF FAULTS (Continued)

TYPE OF FAULT(S)	CAUSE OF FAULT(S)	REQUIRED CORRECTIVE ACTION
SHORT CIRCUIT) (S/C), CROSS) * or CONTACT (X)) (*May be associated with Foreign Battery (FB)).	Line wire(s) - slack	Re-regulate.
	Line wires - tangled.	Untangle and re-regulate.
	Movement of pole due to loose stay.	Adjust the stay.
	Insufficient spacing between line wires.	Check for loose crossarm(s) brace(s), combiner(s) and transposition fitting(s). Tighten or replace bolt(s) and/or coach screw(s) where required.
	Defective insulation on bridle wires.	Replace bridle wires.

TABLE 2 : TYPICAL FAULTS, CAUSES & CORRECTIVE ACTIVITIES (Continued next page)

CLEARANCE OF FAULTS (Continued)

TYPE OF FAULT(S)	CAUSE OF FAULT(S)	REQUIRED CORRECTIVE ACTION
SHORT CIRCUIT) (S/C), CROSS) * on CONTACT (X)) (*May be associated with Foreign Battery (FB)). (Continued)	Flying objects, tree limbs, bare wire lying across bare line wires.	Remove.
	Birds nests, spider webs.	Remove.
EARTH (Eth.) OR GROUND (Gnd.).	Operated arrester(s).	Replace arrester(s).
	Line wire(s) touching an earthed object on pole.	Check for broken insulator(s) or broken tie wire. Replace if required. Check cross-arm(s), brace(s), combiner(s) and transposition fitting(s) for looseness. Tighten or replace bolt(s) and/or coach screw(s) where required.
	Line wire(s) down.	Re-erect line wire(s) and regulate.

TABLE 2 : TYPICAL FAULTS, CAUSES & CORRECTIVE ACTIVITIES (Continued next page)

CLEARANCE OF FAULTS (Continued)

TYPE OF FAULT(S)	CAUSE OF FAULT(S)	REQUIRED CORRECTIVE ACTION
EARTH (Eth.) or GROUND (Gnd.). (Continued)	Tree, undergrowth touching line wire(s).	Lop the tree, undergrowth.
LOW INSULATION RESISTANCE (L.I.R. or Low I.R.)* (*May be associated with Foreign Battery (FB)).	Dirty, porous or cracked insulator(s).	Replace insulator(s).
	See SHORT CIRCUIT (S/C), CROSS or CONTACT (X) faults above.	
OPEN CIRCUIT (O/C).	Line wire(s) down.	Re-erect line wire(s) and regulate.
	Defective bridle wires.	Replace bridle wires.

TABLE 2 : TYPICAL FAULTS, CAUSES & CORRECTIVE ACTIVITIES (Continued next page)

CLEARANCE OF FAULTS (Continued)

TYPE OF FAULT(S)	CAUSE OF FAULT(S)	REQUIRED CORRECTIVE ACTION
OPEN CIRCUIT (O/C) or HIGH RESISTANCE (H.R.).	Defective press type sleeve connection(s).	Replace press type sleeve(s).
	Defective drip point sleeve connection(s).	Replace drip point sleeve(s).
	Defective Britannia joint connection(s).	For line wire(s) up to and including 2.84 mm replace defective Britannia joint(s) with an appropriate press type sleeve(s). For G.I. line wire(s) of higher gauges - make new Britannia joint(s).
	Defective twist type sleeve connection(s).	For line wire(s) up to and including 2.84 mm replace defective twist type sleeve(s) with an appropriate press type sleeve(s). For G.I. line wire(s) of higher gauges - make new Britannia joint(s).

TABLE 2 : TYPICAL FAULTS, CAUSES & CORRECTIVE ACTIVITIES (Continued next page)

CLEARANCE OF FAULTS (Continued)

TYPE OF FAULT(S)	CAUSE OF FAULT(S)	REQUIRED CORRECTIVE ACTION
OPEN CIRCUIT (O/C) or HIGH RESISTANCE (H.R.). (Continued)	Unsatisfactory contact in openable wire joint connector(s).	Tighten nut in the connector(s) or replace the connector(s).

TABLE 2 : TYPICAL FAULTS, CAUSES & CORRECTIVE ACTIVITIES

WHEN LOPPING TREES, OBTAIN FIRM FOOTHOLD ON TREE
OR LADDER - DON'T SIT ON BRANCH TO WORK.

REPAIRING CONDUITS AND JOINTING CHAMBERS

This Section will be issued at a later stage

THERMOFIT WRAPAROUND REPAIR SLEEVES

ONLY BY WORKING SAFELY TODAY CAN YOU BE SURE THAT YOU WILL BE ABLE TO WORK TOMORROW.

GENERAL

Wraparound Repair Sleeves (WRS) (see Fig. 1) are used to repair moisture barrier

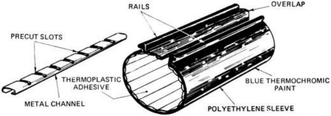


FIG. 1 : THERMOFIT WRAPAROUND REPAIR SLEEVE

or lead sheathed cables. Table 1 below should be used as a guide to the required size of WRS for various cable sizes. If in doubt about the correct size of WRS required, measure the cable or sleeve and select the largest sleeve which will shrink down on to the cable (see Columns 3 and 4). The sleeve must be a loose fit over the cable in all cases as too tight a fit can result in splitting of the material during the shrinking process.

WHEN USING A LADDER SECURE THE BOTTOM AGAINST SLIPPING. TIE THE HEAD OF THE LADDER TO THE POLE.

GENERAL (Continued)

Serial/ Item	WRS Number	Cable Diameter	Cable Circumference	Serial 470 PIUT Cable MB			
				0.32	0.40	0.64	0.90
433/161	100-120-5	25 mm to 30 mm	79 mm to 97 mm		150 200		
433/162	120-160-5	30 mm to 40 mm	94 mm to 130 mm	600 1000	300 400	150 200	
433/163	160-198-5	40 mm to 50 mm	127 mm to 160 mm	1200	600	300	150
433/164	190-234-5	48 mm to 60 mm	150 mm to 188 mm	1800	800 1000	400	200
433/165	229-227-5	58 mm to 70 mm	183 mm to 225 mm	2400	1200 1400	600	300
433/166	272-350-5	69 mm to 90 mm	216 mm to 279 mm	3000 4200	1800 2400 2700	800 1000 1200	400 600

TABLE 1 THERMOFIT WRAPAROUND REPAIR SLEEVE SIZES

NOTE: The WRS material is supplied in 1.5m lengths with metal channel in 760 mm lengths.

THERMOFIT WRAPAROUND REPAIR SLEEVES

PREPARING CABLE FOR WRAPAROUND REPAIR SLEEVES

Before fitting WRS prepare the sheath as follows:

Moisture Barrier Sheath

(i) Clean sheath over sleeve area with methylated spirits and wipe dry.

(ii) If sheath has been damaged trim away any projections.

(iii) Lightly abrade sheath with a file card or wire brush over the area to be covered by the sleeve. Apply card or brush around the circumference of the cable, not longitudinally along its length.

Lead Sheath or Lead Joint Base

(i) Lightly abrade lead with a file card or wire brush to remove oxide and dirt.

(ii) Wipe clean and dry.

Polythene Jacketed Lead Sheath

(i) For repair of polythene jacket only, prepare cable as described for moisture barrier sheath above.

(ii) Where the lead sheath has been damaged, trim away damaged polythene jacket and repair lead sheath by plumbing. Clean polythene jacket and lead sheath thoroughly as described above.

FITTING WRS ON PRESSURISED CABLES

WRS cannot be applied over a leak in a pressurised cable

Cables under air pressure must be vented and bled to zero pressure before and during application of the sleeve. The thermoplastic adhesive solidifies in 15 minutes and air pressure may then be restored to the cable.

LPG BURNER FOR SHRINKING WRS

Use only a special "soft flame" LPG burner for shrinking WRS. Plumbing type burners are unsuitable for use with thermoshrinkable tubing as the flame is too concentrated and may damage the material.

FITTING WRAPAROUND REPAIR SLEEVE

(i) Select a WRS of the size required (see Table 1).

(ii) Cut WRS to length allowing 150 mm overlap beyond the point to be sealed. Thus minimum length will be 300 mm, which is the correct length to use when repairing a nail hole in the sheath.

Cut WRS cleanly with no ragged edges using scissors, metal shears or a sharp knife and straight edge. Make the cut square with the sides of the WRS so that the rails coincide when the material is folded.

(iii) Break the metal channel by flexing at the desired point so that it overlaps the WRS by 2 to 6 mm at each end. After breaking, the channel will have two rough protrusions at the end which must be cut off and the edges dulled with a file before sliding the channel onto the WRS.

FITTING WRAPAROUND REPAIR SLEEVE (Continued)

(iv) Wrap WRS around the cable with the rails on top (see Fig. 2). The overlap section should face the jointer to ensure that this area will receive sufficient heat when shrinking the sleeve.

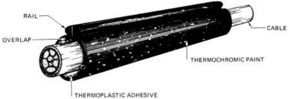


FIG. 2 : FITTING WRS ON CABLE

(v) Place rails together so that they are flush and aligned at ends.

(vi) Slide a length of closure channel over the WRS rails (see Fig. 3) to hold the sleeve together. The channel should extend 2 to 6 mm beyond each end of the sleeve.

PROTECT CABLE CONDUCTORS AGAINST CONTACT WITH MOIST MANHOLE WALLS.

FITTING WRAPAROUND REPAIR SLEEVE (Continued)

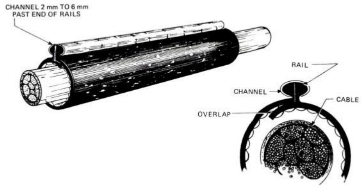


FIG. 3 : FITTING CLOSURE CHANNEL

(vii) To joint two short lengths of channel, fit short channels over rails leaving a 10 mm gap at the center (see Fig. 4). Place a 125 mm Retaining Clip centrally over the gap and snap tightly over the channel with a light tap.

FITTING WRAPAROUND REPAIR SLEEVE (Continued)

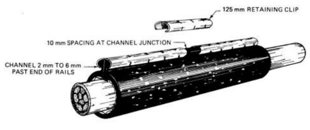


FIG. 4 : JOINTING TWO SHORT LENGTHS OF CHANNEL

(viii) Heat WRS with a soft flame (i.e., predominantly yellow) to shrink it down on to the cable and to melt the thermoplastic adhesive on its undersurface. Use only the special soft flame LPG burner for this purpose.

Heat the WRS with an oscillating motion (see Fig. 5) of the flame keeping the yellow portion of the flame on the tubing and moving it

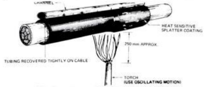


FIG. 5 : SHRINKING WRS

FITTING WRAPAROUND REPAIR SLEEVE (Continued)

continually to ensure an even distribution of the heat. Start heating at one end of the WRS and work towards the other end of the sleeve. Do not heat the sleeve from both ends towards the center as this will create a trapped air bubble. Start at the bottom of the sleeve applying heat over all surfaces until shrinking occurs. Continue applying heat until the heat sensitive blue colour spots on the surface turn a light brown indicating the proper temperature has been reached and the thermoplastic adhesive has melted.

Wrinkles will develop between the heated and unheated parts of the sleeve as shrinking occurs. These will disappear when the sleeve has been heated to the correct temperature. Move flame back and forth and gradually work across the entire length of the sleeve. Apply more heat to areas where blue paint spots have not changed colour. Adhesive forced out of the ends of the sleeve indicates that heating can be discontinued.

The thermoplastic adhesive solidifies in approximately 15 minutes and the cable can then be placed under gas pressure.

REMOVING WRAPAROUND REPAIR SLEEVE

Should it ever become necessary to remove a WRS sleeve or other thermoshrinkable tubing proceed as follows:

(i) Release any gas pressure in the cable.

REMOVING WRAPAROUND REPAIR SLEEVE (Continued)

(ii) Using a similar torch as for the installation, heat the entire length of the sleeve until the thermochromic paint spots turn brown indicating that sufficient heat has been applied to melt the adhesive. Care should be taken not to overheat the adhesive at the ends of the sleeve as it can catch alight.

(iii) Using a sharp knife cut the sleeve along its length over the overlapping section to minimise the possibility of damage to the cable sheath. Only light cutting pressure is needed as the sleeve will be softened by heating. The sleeve will now split along the length of the cut when further heat is applied.

(iv) By grasping the metal channel with pliers the sleeve can be peeled from the cable. If the adhesive has solidified in any places, removal will be impeded but a little more heat will remelt the adhesive allowing complete removal.

(v) Discard the old sleeve and metal channel.

A new sleeve may be readily applied over the original area if required. Any adhesive already on the cable will melt and blend into the adhesive of the new sleeve when heat is applied. If the cable has been handled it should first be cleaned with methylated spirits.

NOTE: The thermochromic paint on WRS will change back to a blue colour by absorbing moisture from the air, and on cold, wet days this can take place in as little as 30 minutes.

FAULT RECORDING AND ANALYSIS - A.L.F.A.

IT IS NOT ONLY FAULT STAFF WHO ARE REQUIRED TO SEE THAT AN A.L.F.A. FAULT DOCKET IS PREPARED. OTHER LINES STAFF HAVE A SIMILAR RESPONSIBILITY WHEN THEY ARE REQUIRED TO CLEAR FAULTS.

FAULT RECORDING AND ANALYSIS - A.L.F.A.

GENERAL

A.L.F.A. (Automatic Line Fault Analysis) is a computerised system of fault recording and analysis of line faults. It provides information for local use and for Management at State and National levels.

FAULT DOCKETS AND CODES

Line fault data is gathered in the field by line faultmen after clearance of each fault. An appropriate A.L.F.A. fault docket (E33 - see Fig. 1, or E34A - see Fig. 2) is prepared for each line service affecting or non-service affecting fault.

The line faultman clearing the fault is responsible for the preparation of the relevant fault docket or for passing on the fault details to the fault center. This includes special studies which may be undertaken in a particular area.

The fault details gathered at the fault site are to be coded accurately using the code card E31 (or E31A) which contains CABLE and ITP FAULT CODES on the front side (see Fig. 3) and AERIAL CODES on the reverse side (see Fig. 4). The code card E31A is identical to the code card E31 except for size. It is smaller, and when folded it fits into the Faultman's Notebook E434.

Completed fault dockets are to be posted daily to the Fault Foreman.

A.L.F.A. FAULT DOCKETS ARE THE LIFE BLOOD OF THE FAULT ANALYSIS SYSTEM. SEE THAT ONE IS PREPARED FOR EVERY FAULT.

FAULT DOCKETS AND CODES (Continued)

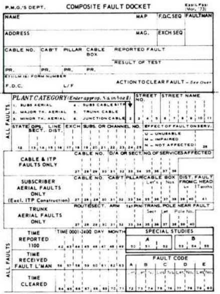
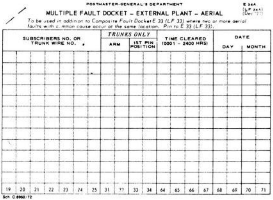

P.M.G.'S DEPT. COMPOSITE FAULT DOCKET E33(LF33) (Mar. '73)
NAME | MAP | F.D.C. SEQ | FAULTMAN
ADDRESS | MAG. | EXCH SEQ
CABLE NO. | CAB'T | PILLAR | CABLE BOX | REPORTED FAULT
RESULT OF TEST
PR. | PR. | PR. | PR.
E71(LM 16) FORM NUMBER
F.D.C. | L/F | ACTION TO CLEAR FAULT – *See Over*
ALL FAULTS
PLANT CATEGORY (Enter approp. No. in box 2)
1. SUBS AERIAL 4. SUBS CABLE & ITP
2. MAJOR TK. AERIAL 5. TRUNK CABLE
3. MINOR TK. AERIAL 6. JUNCTION CABLE
STREET NO. | STREET NAME
2 3 4 5 6 7 8 9 10 11
STATE | OPS. SECT. | LINE DIST. | EXCH | SUBS. OR CHANNEL NO. | EFFECT OF FAULT ON SERV.
U – UNUSABLE
M – IMPAIRED
N – NOT AFFECTED
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
CABLE & ITP FAULTS ONLY | CABLE NO. | D/A OR SECT. | NO. OF SERVICES AFFECTED
27 28 29 30 31 32 33 34 35 36 37 38
SUBSCRIBER AERIAL FAULTS ONLY (Excl. ITP Construction) | CABLE NO. | CAB'T | PILLAR | CABLE BOX Let's Nos | DIST. FAULT FROM C. HEAD Km Tenths
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
TRUNK AERIAL FAULTS ONLY | ROUTE | SECT. | ARM | 1st PIN | TRANS. POLE NEAR FAULT Sect Let Pole No.
27 28 29 30 31 32 33 34 35 36 37 38 39 40
ALL FAULTS
TIME REPORTED 1100 | TIME 0001-2400 | DAY | MONTH
42 43 44 45 46 47 48 49
SPECIAL STUDIES A B
50 51 52 53 54 55
TIME RECEIVED FAULT L'MAN
56 57 58 59 60 61 62 63
FAULT CODE A B C D E
Let Let No. Let No. Let. No. Let No.
TIME CLEARED
64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

FIG. 1 : COMPOSITE FAULT DOCKET E33 - ALL FAULTS


POSTMASTER-GENERAL'S DEPARTMENT
E 34A (LF 34A) (Dec '71)
MULTIPLE FAULT DOCKET – EXTERNAL PLANT – AERIAL
To be used in addition to Composite Fault Docket E 33 (LF 33) where two or more aerial faults with common cause occur at the same location. Pin to E 33 (LF 33).

SUBSCRIBERS NO. OR TRUNK WIRE NO.							TRUNKS ONLY ARM		TRUNKS ONLY 1ST PIN POSITION		TIME CLEARED (0001 – 2400 HRS)				DATE DAY		DATE MONTH	
19	20	21	22	23	24	25	31	32	33	34	64	65	66	67	68	69	70	71

Sch C.8960/72

FIG. 2 : MULTIPLE FAULT DOCKET E34A - AERIAL FAULTS

FAULT DOCKETS AND CODES (Continued)

FIG. 3 : CODE CARD E31 - FRONT SIDE-CABLE AND ITP FAULT CODES

FIG. 4 : CODE CARD E31 - REVERSE SIDE - AERIAL FAULT CODES

FAULT DOCKET INSTRUCTION CHARTS

Instructions for the preparation of fault dockets are contained in the following series of charts:

(i) Composite Fault Docket Chart - E52

(see Fig. 5) is used for preparation of fault dockets associated with subscriber aerial faults.

(ii) Composite Fault Docket Chart - E53

(see Fig. 6) is used for preparation of fault dockets associated with trunk aerial faults.

(iii) Composite Fault Docket Chart - E54

(see Fig. 7) is used for preparation of fault dockets associated with subscriber cable and I.T.P. faults.

(iv) Composite Fault Docket Chart - E55

(see Fig. 8) is used for preparation of fault dockets associated with trunk and junction cable faults.

(v) Composite Fault Docket Chart - E51

(see Fig. 9) shows how to complete fault dockets for local control purposes, generally in Fault Despatch Centers.

A.L.F.A. FAULT CODES CAN BE ALTERED. IF YOU THINK AMENDMENTS ARE REQUIRED, SEND ADVICE TO THE LINES SERVICE SECTION AT HEADQUARTERS.

FAULT DOCKET INSTRUCTION CHARTS (Continued)

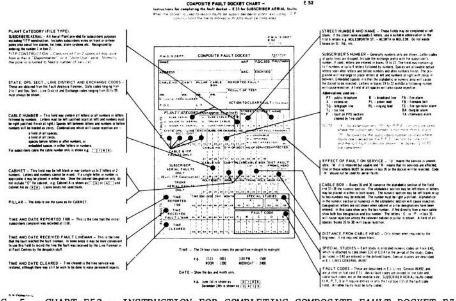


FIG. 5 : CHART E52 - INSTRUCTION FOR COMPLETING COMPOSITE FAULT DOCKET E33 FOR SUBSCRIBER AERIAL FAULTS

FAULT DOCKET INSTRUCTION CHARTS (Continued)

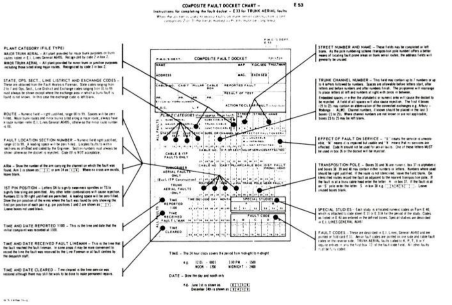


FIG. 6 : CHART E53 - INSTRUCTION FOR COMPLETING COMPOSITE FAULT DOCKET E33 FOR TRUNK AERIAL FAULTS

FAULT DOCKET INSTRUCTION CHARTS (Continued)

COMPOSITE FAULT DOCKET CHART – E 54

Instructions for completing the fault docket – E 33 for SUBSCRIBER CABLE AND I.T.P. faults

PLANT CATEGORY (FILE TYPE)

SUBSCRIBER CABLE AND I.T.P. – Includes all cable plant other than trunk and junction cables. ITP plant*, because it is commonly associated with distribution area type construction, is included in this plant category. Recognized by code 4 in box 2.

**I.T.P. Plant – Consists of 1 or 2 spans of drop wire from either a "Departmental" or a "Joint Use" pole. Normally the pole is situated to feed a number of services.*

STATE, OPERATIONS SECTION, LINE DISTRICT AND EXCHANGE CODES are obtained from the Fault Analysis Foreman. State codes ranging from 2 to 7 and Operations Section, Line District and Exchange codes ranging from 01 to 99 must always be shown.

CABLE NUMBER – This field may contain all letters or all numbers or letters followed by numbers. Letters must be left justified (start at left) and numbers must be right justified (finish at right). Spaces left between letters and numbers or before numbers will be treated as zeros. Combinations which will cause rejection are :-

- a field of all spaces,
- a field of all zeros,
- spaces before letters or after numbers, or
- embedded spaces in either letters or numbers.

For subscribers cable the cable number only is shown e.g. [| | 1 | 8 | 4]. Instead of cable number this field may be used to show "O" pair (distribution pair) number by the use of prefix "X". For example, show 'O' pairs as X--1, X-11, X111 etc. Similarly, branch and main pairs can be defined by the use of prefix 'B' (branch) and 'M' (main).

DISTRIBUTION AREA OR SECTION – This field may contain all letters or all numbers or letters followed by numbers. Letters must be left justified and numbers right justified. Spaces left between letters and numbers or before numbers will be treated as zeros. The field may be left blank if no distribution area or fault section number exists. Combinations which will cause rejection are :-

- spaces preceding letters or after numbers,
- embedded spaces in either letters or numbers.

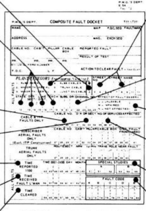
For subscribers cable the D/A (distribution area) or Section Number is to indicate the location in which the fault is found so that fault prone areas can be recognized. Should the D/A have a letter as part of its designation (such as where one is split and designated "A") enter the letter in the left hand box e.g. [A | | 1 | 8 | 5]. Section numbers are sometimes given to cables beyond the last D/A. However, if no section number is given, use the number of the last D/A the cable passed through. Only distribution or lead in plant should be given a D/A No. Enter [M | A | I | N] for faults in main cable and [B | R | C | H] for faults in branch cable. For rural areas, cable plan numbers may be used in this field.

TIME AND DATE REPORTED 1100 – This is the time and date that the subscribers initial complaint was recorded at 1100.

TIME AND DATE RECEIVED FAULT LINEMAN – This is the time that the fault reached the fault lineman. In some areas it may be more convenient to record the time the fault was received by the Line Foreman or at Fault Centres by the despatch staff.

NOTE: *In most cases "non service affecting" faults i.e. G.P.A. faults, sheath corrosion in cable under pressure, etc. are reported by means other than through 1100. In this case the "TIME REPORTED 1100" field (boxes 42 to 49) is left blank and the "TIME RECEIVED FAULT LINEMAN" will be taken as the initial report of the fault.*

TIME AND DATE CLEARED – Time cleared is the time service was restored although there may still be work to be done to make permanent repairs.



TIME – The 24 hour clock covers the period from midnight to midnight

e.g. 12.01 = 0001 3.00 PM = 1500
NOON = 1200 MIDNIGHT = 2400

DATE – Show the day and month only

e.g. June 1st is shown as [0 1 | 0 6]
December 24th is shown as [2 4 | 1 2]

STREET NUMBER AND NAME – **These fields may be completed or left blank. If the street name exceeds 6 letters use either a suitable abbreviation or the first 6 letters e.g. MOLESWORTH ST. = MLSWTH or MOLESW. Do not waste boxes on St., Rd., etc.**

SUBSCRIBERS NUMBER – Generally numbers only are shown. Letter codes of party lines are dropped. Include the exchange prefix with the subscribers number. If used, letters are entered in boxes 19 to 22. The field may contain up to 7 numbers or up to 4 letters followed by numbers. Spaces are allowable before letters start after letters and before numbers and after numbers finish. The programme will rearrange to place letters at left and numbers at right with zeros in between. Embedded spaces in either the alphabetic or numeric area will cause the docket to be rejected. Letters in boxes 19 to 22 without a following number will cause rejection. A field of all spaces will also cause rejection. For non-service affecting faults show a number or letter number combination. Letters only (boxes 19 to 22) will cause rejection. Acceptable combinations are GPA---Ø, CORR--Ø, RPTR--Ø etc. A single zero (Ø) is also acceptable.

Abbreviations used are –

PT = public telephone	B = broadcast line	FA = fire alarm
X = extension	PL = power lead	FB = firemans bell
TG = telephone line	RL = ringing lead	FS = fire sprinkler alarm
TL = tie line		BA = burglar alarm
P = fault on PPE section cleared by line staff		TA = tramways alarm

These abbreviations must be followed by a number, e.g. PT----Ø, X--5565 etc.

NOTE *"X" for extension and "P" for P.P.E. can only be used where the subscribers number is not more than 6 digits. "P" followed by the subscribers number is used where faults are cleared on the P.P.E. section by line staff and the full fault codes are shown, i.e. boxes 72 to 80 are completed.*

EFFECT OF FAULT ON SERVICE – "U" means the service is unworkable, "M" means it is impaired but usable and "N" means that no services are affected such as in a G.P.A. system fault. ONE of these letters must be shown in box 26 or the docket will be rejected.

NUMBER OF SERVICES AFFECTED – This field may contain up to 4 numbers which must be right justified. Spaces will be zero filled. If box 26 is "U" or "M" the minimum value is 1. If 26 is "N" the field is left blank. The number of subscribers, fire alarms, etc. affected must be shown. Spare pairs do not count as services.

SPECIAL STUDIES – Each study is allocated numeric codes on Form E 40, which is attached to code sheet E 31 or E 31A for the period of the study. Codes as listed in E 40 are entered in the defined boxes. Special studies are described in E.I. LINES GENERAL A6497.

FAULT CODES – These are described in E.I. Lines, General A6492, and are printed on fold card E31. Cable fault codes are printed on one side and aerial fault codes are on the reverse side. Subscriber cable and I.T.P. faults coded to K, P, T, X, Y or Z require entries in only the first box (72) of the code field. All other faults must be fully coded.

FIG. 7 : CHART E54 - INSTRUCTION FOR COMPLETING COMPOSITE FAULT DOCKET E33 FOR SUBSCRIBER CABLE AND I.T.P. FAULTS

FAULT DOCKET INSTRUCTION CHARTS (Continued)

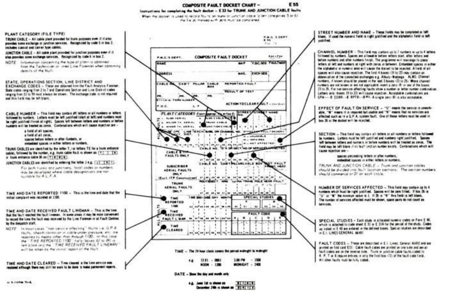


FIG. 8 : CHART E55 - INSTRUCTION FOR COMPLETING COMPOSITE FAULT DOCKET E33 FOR TRUNK AND JUNCTION CABLE FAULTS

FAULT DOCKET INSTRUCTION CHARTS (Continued)

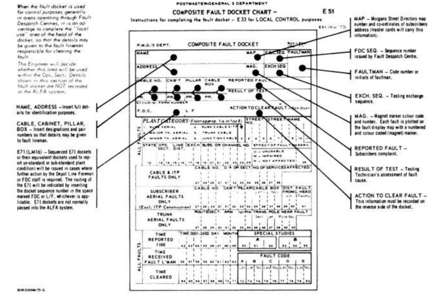


FIG. 9 : CHART E51 - INSTRUCTION FOR COMPLETING COMPOSITE FAULT DOCKET E33 FOR LOCAL CONTROL PURPOSES

FAULT REPORTS

Two types of fault reports are provided by the computer from the fault dockets submitted by the Lines Staff, namely OPERATIONAL REPORTS and ANALYSIS REPORTS.

(i) OPERATIONAL REPORTS - These reports give details of Plant Performance, Excessive Faults, Recurring Faults and Clearance Times. PERFORMANCE REPORTS are used to locate the worst exchange areas, as well as the worst trunk route or junction route sections. EXCESSIVE FAULTS REPORTS are used to locate the worst distribution areas and subscribers' pole routes. RECURRING FAULTS ON SERVICES REPORTS show the grade of service provided to individual customers, while CLEARANCE TIME REPORTS allow a check to be made on fault clearance targets.

(ii) ANALYSIS REPORTS - These reports are provided for each Operations Section and are summed up to provide State and National totals. They provide analyses of fault causes and the fault totals and are an aid to Management in the States and at Headquarters.

Tables and graphs prepared from the information contained in the ANALYSIS REPORTS show:

Major causes of faults,
Type of plant affected,
Fault incidence trends,
Plant performance.

USE OF A.L.F.A. INFORMATION

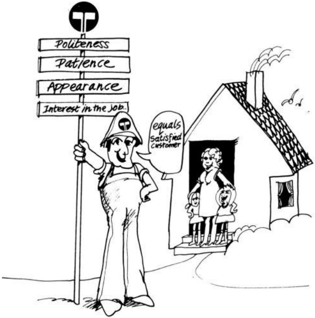
The information provided by A.L.F.A. is used by Management in the States and at Headquarters to:

* (i) Identify line plant or services having high fault incidence,
- (ii) Assess maintenance workload so that the available maintenance resources can be effectively allocated.
- (iii) Detect line fault incidence trends and decide priorities for maintenance project work.
- (iv) Provide a broad indication of the distribution of faults of various types in line plant which may be due to bad installation practices, lack of training, unsatisfactory plant layout or incorrect maintenance practices.

* (v) Assist in the design of new plant materials and the development of new installation and maintenance practices.

A.L.F.A. cannot, and is not intended to answer questions relating to all local fault problems of the line plant. It will however, if properly used, provided many answers, including identification of areas where problems exist, thus allowing concentration of maintenance efforts on areas where the greatest possible benefit can be obtained.

Conditions may sometimes prevent the full use of A.L.F.A. locally. It is important, * however, that line fault data is gathered and a fault docket is prepared for every fault to meet the State and the National requirements.



That's what satisfies customers

TELEPHONE NUMBERS

Exchange	Access No.	
	A.P.R.	S.A.L.T.

Name	Phone No.