OPTICAL FIBRE CABLE OPERATIONS AND MAINTENANCE HANDBOOK

TPH 2281 (E) EP

Explanatory Note

This is a complete new Issue 1, 1987.
This handbook contains details about operations and maintenance of Optical Fibre Cables.

For details about new installations you should refer to the new issue of the Linemens Handbook, "Optical Fibre Cable Installations," Issue 2, 1987.
The title of that handbook has been changed.
Both handbooks include each others index as a quick reference.

Handbook contents are distributed/ordered from the State Distribution office while covers, are ordered from Supply Branch.

Details for ordering covers are :
Serial 225/52 Cover, Linemens Handbook "Optical Fibre Cable Operations and Maintenance."
Serial 225/49 Cover, Linemens Handbook "Optical Fibre Cable Installation".

December 1987

TPH 2281 (E) EP

Linemens Handbook

Optical Fibre Cable Operations & Maintenance

Issue 1 — 1987

Filing Category: E, Lines General
Distribution Code: 2E 4H 4L 7J Selected Staff
File/Author Code: EE 3M H EP

Telecom Australia

Author Area :	Standardisation and Services Section External Plant Customer Access Networks Branch Headquarters (03) 606 6881
Authorised By :	Superintending Engineer External Plant Customer Access Networks Branch Transmission Division Headquarters
Distribution Point :	Senior Technical Officer External Plant Inter-Exchange Networks Branch Standardisation and Services Section Transmission Division Headquarters
Keywords :	. Lines Cables . Linemens handbooks . Optical Fibre Cable . Maintenance

Section

A Contents List
Index
On The Line
Suggestions

Safety

B Location of Optical Sources
Responsibilities
Safety Factors
Safety Features
Laser Radiation
System Safety Features
Laser Safety Requirements
Laser Safety Procedures
Common Safety
Specific Safety
Signs, Labels and Their Location

Training

C Test Equipment
Training

Optical Fibre - Identification

D Single Mode Fibres
Multi Mode Fibres
Fibre Colour Code
Unit Identification

Routine Maintenance and Responsibilities

E Monitoring Systems
Route Surveillance
Staff Responsibilities
Equipment Maintenance
- BICC Model Splicing Machine
- Northern Telecom Splicing Machine
- Furukawa Splicing Machine
Functions and Duties of Route Surveillance Team
Tools, Materials and Equipment Check List.

Equipment Spares and Storage

F Stock Holdings of Maintenance Equipment and Spares
Location of Maintenance Equipment and Spares
Responsibilities
Storage Conditions

Fault Notification Actions and Location

G Fault Causes
Fault Indication
Actions and Responsibilities
Fault Reporting
Fault Location
Optical Time Domain Reflectometer
Transponder Peg Detector

Repair Techniques and Options

H Compulsory Requirements
Responsibilities of Staff
First-In Emergency Repair
Cable Cutover Schedule
Terminations - Faults and Remedies
Emergency Cable
Testing after Repair Works
Communications

Emergency Repair Splicing of Optical Fibre Cable

I Cable Faults
Fault Location
Safety Precautions
G.T.E. Elastomeric Splices

Emergency Repair Splicing of Optical Fibre Cable (Cont'd)

I Method 1 : Repair Procedures Using Siemens Joint Closures
Method 2 : Repair Procedures Using Split Conduit
Acceptance Testing of Completed Splices

Field Fitting Hauling Eyes

J Safety Requirements
Installing Hearthill Type Hauling Eye
Installing Sumitomo Type Hauling Eye
Post Hauling Testing/Action

Remote Area Repeater Maintenance Requirements

K Inspection
Repeater Maintenance
Earth System Inspection

Acceptance Testing of Completed Splices I-23
Actions and Responsibilities, Cable Restoration Controller G-4
Alarm Systems, Monitoring E-2
Buried Cable, Exposing G-18
Cable, Pressurised B-8
Cable, Emergency H-6
Cable, Interruption H-7
Cable, Faults I-2
Cable, Rapid Deployment H-7
Cable Cutover Schedule H-11
Cable Faults, Reporting Procedure G-11
Cable Repair Procedures, Flow Charts G-7
Cable Pressure Alarm Systems G-3
Cable Restoration Controller E-4
Cable Restoration Controller, Responsibilities G-4
Check List, Tools and Materials E-16
Closures UC B-8
Colour Code of Fibres D-8
Colour Identification Scheme for Fibres D-10
Communications, Repair Work H-16
Common Safety B-7
Construction of Single Mode Fibre D-2
Construction of Multi Mode Fibre D-4
Construction of Slotted Core Cable D-5
Construction of Loose Tube Cable D-6
Cross Section of Pressurised Cable D-7
Detector Peg, Transponder G-21
Detector Unit, Transponder Peg G-22
Detector Unit, Maintenance G-31
Ducted Cable, Exposing G-20
Duties of Route Surveillance Team E-13
Earth System, Remote Area Repeater K-7
Elastomeric Splice I-7
Emergency Cable H-6
Emergency Repair Splicing I-1
Emergency Repairs, Safety Precautions I-4
Equipment Maintenance E-6
Equipment Spares and Storage F-1
Exposing Buried Cable G-18
Exposing Ducted Cable G-20
Fault Reporting G-11
Fault Reporting H-4
Fault Location I-3
Fault Location G-14
Fault Causes G-2
Fault Indication G-2
Fault Notification, Action and Locating G-1

Fault Restoration Techniques B-2
Fault Report Form E1245 G-13
Fault Location, OTDR Methods G-17
Fault Repairing H-5
Faults and Remedies, Terminations H-13
Fibre Colour Code D-8
Fibre Colour Identification Scheme D-10
First-In Emergency Repair Options H-5
First-In Emergency Repair H-15
Fitting Hauling Eyes J-1
Flow Charts, Cable Repair Procedures G-7
Functions and Duties of Route Surveillance Team E-13
General Safety B-7
Glasses Safety 1-5
G.T.E. Elastomeric Splices I-6
Hauling Eyes, Field Fitting J-1
Hauling Eyes, Testing J-20
Hearthill Hauling Eyes J-2
Holding of Stock, Spares F-2
Identification of Units D-9
Identification of Optical Fibres D-1
Identification Scheme for Fibres D-10
Inspection of Repeater Shelters K-2
Installation of Interruption Cable H-9
Installing Hearthill Hauling Eyes J-5
Installing Sumitomo Hauling Eyes J-16
Joint Closure, UC Type I-18
Joint Closure, Split Conduit I-18
Jointing Copper Conductors, Emergency Repairs I-13
Labels, Signs and Their Location B-12
Labelling Spare Cable H-14
Laser Shut-off H-2
Laser Safety Requirements B-5
Laser Safety Procedures B-5
Location of Faults G-14
Location of Signs and Labels B-12
Location of Spare Emergency Cable H-13
Location of Maintenance Equipment and Spares F-6
Location of Optical Sources B-11
Locating Marker Pegs G-21
Maintenance and Responsibilities E-1
Maintenance Equipment and Spares, Location F-6
Maintenance of Equipment E-6
Maintenance of Detector Unit G-31
Marker Pegs, Locating G-21
Monitoring Systems E-2

Multimode Fibre Construction D-4
Optical Fibre System, Safety Features B-4
Optical Sources, Location B-11
Optical Fibres, Identifications D-1
Optical Time Domain Reflectometer (OTDR) G-16
OTDR Methods, Fault Location G-17
Other Safety Features B-10
Permanent Repairs to Cables H-5
Permanent Repairs H-15
Piecing Out Fibres H-8
Pressurised Optical Fibre Cable B-8
Pressurised Cable, Cross Section View D-7
Procedure for Repairs H-8
Radio Communications H-16
Reflectometer, OTDR G-16
Repair Procedures G-4
Repair Techniques and Options H-1
Repair Options H-5
Repair Procedures H-8
Repair Work, Communications H-16
Repairs, Permanent H-15
Repairs using UC Closures I-8
Repairs using Split Conduit Closure I-18
Repair Work, Testing H-15
Repeater Shelters, Inspection K-2
Reporting Faults H-4
Report Form for Faults G-13
Remote Area Repeater Maintenance K-1
Responsibilities, Staff Safety B-2
Responsibilities of Staff H-2
Restoration of Fibres H-4
Restoration Techniques for Faults B-2
Route Surveillance E-3
Route Surveillance, Staff Responsibilities E-4
Route Surveillance Team, Functions and Duties E-13
Routine Maintenance and Responsibilities E-4
Safety, Staff Responsibilities B-2
Safety, Common/General B-7
Safety Precautions, Emergency Repairs I-3
Safety Glasses I-5
Safety Requirements B-5
Safety Procedures, Lasers B-5
Safety Features B-10

Safety Requirements, Fitting Hauling Eyes J-2
Schedule For Cutovers H-11
Shutting off Laser H-2
Single Mode Fibre, Construction D-2
Single Fibre Cord H-7
Sizes of Heathill Hauling Eyes J-3
Slotted Core Cable Construction D-5
Solvents B-9
Spare Cable H-6
Interruption and Emergency Cable, Testing H-15
Splice Assembly I-6
Split Conduit Joint Closure I-18
Specific Safety B-8
Staff Safety, Responsibilities B-2
Staff Responsibilities, Route Surveillance E-4
Staff Responsibilities H-2
Staff Communications, Repair Work H-16
Storage of Equipment F-2
Stock Holdings, Maintenance Equipment and Spares F-2
Sumitomo Hauling Eyes J-16
Systems Loss, Transmission G-3
Temporary Joint Closure, Split Conduit I-18
Terminations, Faults and Remedies H-13
Test Equipment C-2
Testing Interruption and Emergency Cable H-15
Testing After Repair Work H-15
Testing of Completed Splices I-23
Testing Installed Hauling Eyes J-20
Training of Staff C-2
Training of Supervisor's C-2
Training Module Flow Chart C-3
Training C-1
Transponder Peg Detector G-21
UC Joint Closure B-8
Unit Identification D-9
Using Detector Unit G-24

Abbreviated Sheath Codes	C-14	Cable Depth	H-26
Above Ground Equipment Shelters (AGES)	M-3	Cable Preparation for Jointing Multimode	I-6
Access Gateways	H-27	Cable Filling Compound, Removing	J-5
Accessories and Equipment	N-1	Cable Circumference, Measuring	K-14
Accessories for Joint Closures	N-6	Cable Records	L-2
Acceptable Splices in Fibres	I-6	Cable Marking Details	L-8
Acceptable Testing of Splices	I-20	Cable Identification Tie	L-9
Adjustment of Drilling Tool, UC Closures	K-14	Cable Entry (UGES) Water and Termite Proofing	M-41
Allowable Bending Radius	H-6	Cable Joint Closures	N-5
Alternative Marker Post System	H-19	Cable Detection System	N-31
Applying Splice Protection	J-20	Capstan Winches	G-30
Applicator Tool for Splice Protector	N-4	Caution Sign	H-17
Application of Optical Fibre Cables	C-5	Cathodic Protection System for Remote Area Equipment	M-12
Bending Radius	H-6	Cathodic Protection System, Testing	M-46
Block, Termite Proof	M-42	Centre Feed Hauling Both Ways	G-42
Branch Joints	J-22	Change of Direction Roller System	G-27
Cable Pressurised	B-8	Closures, Siemens UC	B-8
Cable, Flame Retardant	C-12	Closures, Cable Joint	N-5
Cable Lengths	C-25	Cleansers for Hands	J-6
Cable Drum Lengths	C-26	Cleansing Procedure	J-7
Cable Ordering	C-28	Cleaning and Stripping Cable	J-9
Cable Ordering	H-9	Cleaning Fibres	J-18
Cable Hauling Communications	G-2	Cleaning Tools for Fibres	N-4
Cable Roller	G-27	Class M35 Tractors	H-5
Cable Drums, Lightmass Metal	H-9	Clamping Unit for Sub-Ducts	F-10

Container, Cleaning Solvent	N-4	Design of Single Mode Cable	J-8
Container for Solvent	J-3	Drawings for Sub-Duct Materials	F-4
Construction of Single Mode Fibre	C-2	Drilling Area in End Caps	K-13
Construction of Multimode Fibre	C-4	Drilling Tool Adjustment	K-14
Construction of Multimode Fibre	I-4	Drilling End Caps	K-17
Construction of Slotted Core Cable	C-7	Drum Lengths	C-26
Construction of Loose Tube Cable	C-8	Drum Sizes for Class M35 Tractor	H-6
Connectors, Mechanical Splicing	N-5	Duct Rodding Communications	G-23
Connector for Screen Continuity	K-9	Earth System for UGES & AGES	M-49
Conduit Preparation for Sub-Ducts	F-5	End Cap Installation	K-13
Conduit Cable Guide (Bender)	G-26	Equipment Shelters for Remote Areas	M-1
Common Safety	B-7		
Communications, Cable Hauling	G-2	Equipment and Accessories for Optical Fibre Cable Installations	N-1
Communications, Duct Rodding	G-23		
Communication System for Tractors	H-10	Equipment List for Jointing	J-27
Combination Caution/Location Sign	H-21	Fault Restoration Technique	B-2
Completed Splices	I-19	Filled Fibre Cables	C-6
Components of UC Joint Closures	K-2	Fibre Identification System	C-11
Components of Tool Kit, UC Closures	K-6	Fibre Colouring	C-11
		Fibre Colour Scheme	C-13
Continuity of Screen	K-9	Fibre Cleaving Tools	N-4
Copper Pairs in Fibre Cables	C-24	Fibre Terminations	E-1
Cross Section of Pressurised Cable	C-10	Fibre Joints	I-5
		Fibre Stripping Tools	N-3
Depth for Cable/Transponder/Tape	H-26	Fibre Storage and Distribution Modules	E-3
Details on Plans	L-2		
Details of Cable Marking	L-8	Fitting Joint Closure End Caps	J-13
Detection System for Locating Cable	N-6	Flame Retardant Cables	C-12

Flags for Signalling, Hauling	G-23	Housing Completed Splices	I-16
Freon, Fault Location	B-8	Ideal Fibre End	I-13
Fusion Splicing Machines	N-3	Ideal Fibre Joint	I-15
Gateways	H-27	Identification System for Fibres	C-11
General Safety	B-7	Identification of Units	C-12
Glasses, Safety	J-3	Installation Practices, Quality Assurance	D-1
Guide (Bender) for Sub-Ducts	G-26	Installing Sub-Ducts	F-2
Guide (Bender) for Conduits	G-26	Intermediate Assist Winch	G-34
Hand Cleansers	J-6	Jointing UMMB Multimode Cable	I-1
Handling Unjointed Fibres	I-19	Jointing and Housing Multimode Cable	I-7
Handling Cables, Safety Precautions	G-23	Jointing Machines for Multimode Cable	I-9
Hardware for Sub-Ducts	F-3	Jointing FNPEHJ Optical Fibre Cable	J-2
Hauling Eyes	C-27	Jointing Arrangements For Fibre Cables	J-25
Hauling Sub-Ducts	F-9	Jointing Equipment List	J-27
Hauling Optical Fibre Cable	G-1	Joints in Fibres	I-15
Hauling Cable, Communications	G-2	Joint Closure End Caps, Fitting	J-13
Hauling Long Lengths	G-26	Joint Listing System	J-26
Hauling in Tandem	G-44	Joint Closures, UC Type	K-1
Hauling Tension for Intermediate Assist Winch	G-34	Joint Closure Components	K-2
Hauling Tension Measurement Systems	G-38	Joint Closure (UC) Re-Entry	K-26
Hauling Both Ways, Centre Feed	G-42	Joint Closures for Cable	N-5
Hinged Rubber Jaw	I-11	Joint Closure Accessories	N-6
Housing and Jointing Multimode Cable	I-7	Labels, Signs and their Location	B-12

Lay Up Hauling Method	G-46	Marker Post, Triangular	H-18
Laying Out Multimode Cable for Jointing	I-4	Marking System for Fibre Cables	H-17
		Marking Cables	L-8
Laying Out Cable at Jointing Site	J-9	Marking Tape for Fibre Cables	L-10
Large Capstan Winch	G-30	Materials List for Pole and Solar Array Assembly	M-27
Laser Safety Requirements	B-5		M-27
Laser Safety Procedures	B-5	Metal Drum Sizes for Directly Buried Cable	H-8
List of Jointing Equipment	J-27		
List of Material for Pole and Solar Array Assembly	M-27	Metal Drums, Lightmass	H-9
		Measuring Soil Resistivity	M-47
Listing System for Joints	J-26	Measuring Sheath Opening, UC Closure	K-8
Location of Optical Sources	B-11		
Location of Signs and Labels	B-12	Measuring Cable Circumference	K-14
Location signs	H-17	Mechanical Splicing Connectors	N-5
Loose Tube Cable Construction	C-8	Mobile Change of Direction Roller System	G-29
Loose Tube Cutting Tool	N-3		
Loudspeaking Telephones for Hauling	G-23	Modules for Patching	E-2
		Multimode Fibre Construction	C-4
Long Length Hauling	G-26	Multimode Cable Construction	I-4
Long Length Conventional Hauling	G-41	No-Nik Stripping Tool	I-11
Machines for Fusion Splicing	N-3	Optical Fibre System, Safety Features	B-4
Machines for Jointing Multimode Fibres	I-9		
		Optical Fibre Cables	C-1
Marker Tape	H-21	Optical Fibre Terminations	E-2
Marker Tape, Depth	H-26	Optical Fibre Organisers	J-17
Marker Posts	L-12	Optical Fibre Organisers	N-5
Marker Systems	N-6	Optical Fibre Pigtails	N-7
		Optical Fibre Marking Tape	L-10

Optical Fibre Equipment and Accessories	N-1	Preparing Conduits for Sub-Ducts	F-5
Optical Sources, Location	B-11	Preparation for Jointing Multimode Cable	I-6
Ordering Cable	C-28	Protector for Fibre Splice	J-20
Ordering Cable	H-9	Protection Tubes for Split Fibre Units	J-14
Organiser Fitted to Support Bracket	I-8	Protection Tubes Fitted to Tray	J-17
Organisers for Optical Fibres	J-17	Quality Assurance	D-1
Other Safety Features	B-10	Radio System, Hauling	G-2
Patching Modules	E-2	Radio Co-Ordinators, State	G-4
Peg, Transponder	H-23	Radio System and Range	G-21
Pigtails, Optical Fibres	N-7	Radio System for Tractors	H-10
Plan Details	L-2	Radius Allowed for Bending	M-1
Ploughing and Marking Cable	H-1	Remote Area Equipment Shelters	M-1
Ploughing Optical Fibre Cable	H-3	Re-entering UC Closure	K-26
Ploughing Speeds	H-4	Removing Cable Filling Compound	J-5
Ploughing Tractor, Class M35	H-5	Responsibilities, Staff Safety	B-2
Pole Mounted Solar Array	M-6	Restoration Technique for Faults	B-2
Pole and Solar Array, Materials	M-27	Roller System for Change of Hauling Direction	G-27
Pole Erection, Solar Array	M-34		
Pole Testing, Solar Array	M-40	Route Markings and Plans	L-1
Polarisation Probe, Voltage Measurement	M-45	Route Records of Cable	L-2
		Route Marking System	L-11
Pressure Testing UC Closure	K-26	Rubber Jawed Hinge	I-11
Pressurised Optical Fibre Cable	B-8	Safety, Staff Responsibilities	B-2
Pressurised Optical Fibre Cable	C-9	Safety Requirements, Lasers	B-5
Pressurised Cable, Cross Section View	C-10	Safety, Common/General	B-7

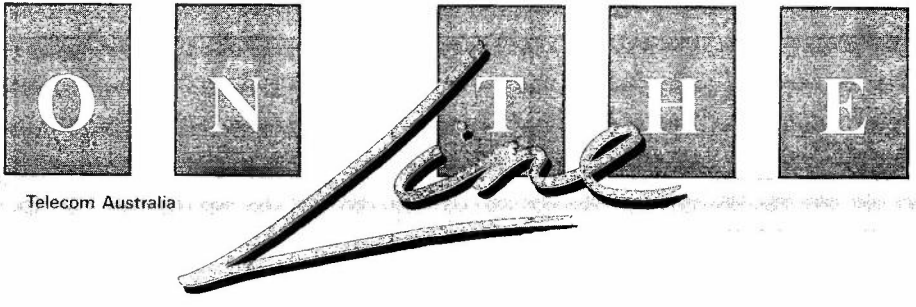
Safety Features	B-10	Solvents	B-9
Safety Precautions, Hauling Cable	G-23	Solvent Container	J-3
Safety Precautions, Jointing	I-2	Solvent Container	N-4
Safety Precautions, Splicing Fibres	J-2	Solar Array, Pole Erection	M-34
		Solar Array Pole, Testing	M-40
Safety Glasses	J-3	Solar Array, Pole Mounted	M-6
Screen Continuity	K-9	Soil Resistivity Measurement	M-47
Screen Continuity Connector	K-9	Specify Safety	B-8
Sealing UB Joint Closure	K-22	Spliced Fibres	1-16
Serial List and Core Sheath Codes, Single Mode Cables	C-14	Splice Protector	J-20
		Splice Protectors	N-4
Serial List and Core Sheath Codes, Multi Mode Cables	C-19	Splice Protector, Thermoshrink	I-10
		Splicing Multimode Fibres	I-9
Sheath Opening, UC Closure	K-8	Splicing of Fibres, Unfinished	I-19
Sheath Continuity	K-12	Splicing Single Mode Cables	J-1
Shelters for Underground Equipment	M-2	Split Fibre Unit Protection Tubes	J-14
Shelters for Above Ground Equipment	M-3	Stripping Tool, No Nick	I-11
	State	Stripping and Cleaning Cable	J-9
Shoring Method for Underground Equipment Shelters	M-15	Stripping Fibre	J-18
	M-15	Stripping Tools for Fibres	N-3
Signs, Labels and their Location	B-12	Star Picket Post Marker	H-19
Sign, Caution	H-17	State Radio Co-ordinators	G-4
Sign Location	H-17	Sub-Duct Materials	F-3
Sign, Combination Caution/Location	H-2	Sub-Duct Hardware	F-3
Single Mode Fibre Construction	C-2	Sub-Duct Welding	F-10
Single Mode Cable Design	J-8	Sub-Duct Installations	F-1
Siemens Stripping Tool	J-19	Sub-Ducts, Preparation for Hauling	F-9
Signal Flags, Hauling	G-23	Sub-Duct Cable Guide (Bender)	G-26
Slotted Core Cable Construction	C-7	System for Tension Measurement	G-38

System (Laser) Safety Features B-4
Tandem Hauling G-44
Tape, Buried H-21
Tape for Marking Cable L-10
Tension Measurement Systems G-38
Termite Proof Block M-42
Termite and Waterproofing (UGES) Cable Entry M-41
Termination Cables E-8
Termination of Optical Fibre Cables E-8
Testing Cathodic Protection System M-46
Thermoshrink Splice Protector I-10
Tie for Identification of Cable L-9
Timbering Method for Underground Equipment Shelters M-15
Tool for Stripping Fibres J-19
Tool Kit Components, UC Closures K-6
Tractor for Ploughing, Class M35 H-4
Tractor Radio System H-10
Trailer Mounted Winch G-32
Triangular Marker Post H-18
Transponder Pegs H-23
Transponder Pegs L-12
Transponder Peg, Depth H-26
Transporting Above Ground Shelters M-21
Tube Cutting Tool N-16
UC Joint Closures K-1
UC Joint Closures B-8
UC Joint Closure, Pressure Testing K-26
Unit Identification C-12
Unit Protection Tube Arrangement J-14
Underground Equipment Shelters (UGES) M-2
UGES and AGES Earth System M-49
Unfinished Splicing of Fibres I-19
Unfinished Joints J-22
Unjointed Fibres, Handling I-19
Visual Acceptance of Splices I-16
Voltage Measurement, Polarisation Probe M-45
Waterproofing Block M-43
Waterproofing UGES Cable Entry M-41
Welding Sub-Ducts F-10
Winches for Hauling G-30

Index Page For State/User Additions

Subject	Page No.	Subject	Page No.

Subject	Page No.	Subject	Page No.



On The Line, the lines staff newspaper, is now over 30 years old, and your efforts have kept it going. Please send in a story whether, personal, technical, on or off the job, or any other suitable material you like. Help is available in preparing your article :

- Photographs, Drawings, Sketches, or Cartoons can be organised by your District/Section office
- If you supply the facts by phone or mail, ON THE LINE can write the story if you prefer.
- Ring us on (03) 606 7696 with any queries at all.

Remember, 20,000 or more readers are waiting to read what you write. The time to act is now.
Issue 1, 1987

SUGGESTIONS SCHEME

Write a brief description of your idea, include sketches where possible and post direct to the above address.

To avoid disappointment and wasting Telecom's time in investigating your suggestion make sure that your ideas are practical. Discuss them with your supervisor and if possible try them out first.
Observe the following helpful tips :

- Use the Staff Suggestion form if possible
- Include Name, Phone Number, and Designation
- Make an effort with your presentation. If the suggestion is good and presentation good, it could earn you cash.

CASH AWARDS

ARE PAID FOR GOOD IDEAS WHICH SAVE TIME, MONEY OR MATERIALS SEND YOURS NOW TO:

FREEPOST 13
TELECOM STAFF SUGGESTIONS
GPO BOX 9884
IN YOUR STATE CAPITAL CITY

GENERAL ENQUIRIES TELEPHONE 03 606 7254

SECTION B

SAFETY

- RESPONSIBILITIES
- SAFETY FACTORS
- SAFETY FEATURES
- LASER RADIATION
- SYSTEM SAFETY FEATURES
- LASER SAFETY REQUIREMENTS
- LASER SAFETY PROCEDURES
- COMMON SAFETY
- SPECIFIC SAFETY
- SIGNS, LABELS AND THEIR LOCATION

Issue 1, 1987

RESPONSIBILITIES

External Plant Staff must be aware of the safety procedures to be observed during the installation, maintenance and testing of optical fibre line terminal and repeater equipment and the operation of associated optical test equipment used in Telecom Australia's optical fibre systems. Warning signs and labels associated with this equipment are also described.

IT IS EVERYONES RESPONSIBILITY ESPECIALLY SUPERVISORS TO BE FAMILIAR WITH EQUIPMENT APPROPRIATE TO THE JOB, WHAT IS AVAILABLE AND HOW TO OPERATE IT CORRECTLY. STAFF MUST ALSO WEAR APPROPRIATE SAFETY CLOTHING AND BOOTS/SHOES.

SAFETY FACTORS

The safety procedures for the staff concerned with the first-in restoration of optical fibre cable will cover a number of facets depending on the cable type, fault restoration technique and the environment.

- Cable Type

  This refers to whether the cable is pressurised or filled and not to whether the cable is single or multimode.

- Fault Restoration Technique

  The method of restoration such as, for example, the use of mechanical connectors or "Interruption Cable" can influence the safety aspects to be considered.

Safety Factors (Cont'd)

Environment

Obviously the location of the fault will dictate the aspects of safety that must be recognised such as that necessary for a fault in the city to that for a fault in rural areas.

SAFETY FEATURES

There are a number of safety features when restoring optical fibre cable that are common to both pressurised and filled cables. Some relate to the jointing of the cables, while others relate to the general external plant environment.
The safety feature that is unique to fibre optic cable is that related to the Laser. This does not mean that other safety features are not important.

Transmission Equipment

It is a requirement that all relevant staff be familiar with the safety precautions for transmission equipment as detailed in draft TPH 0005 section 1 part 5. Although the optical power launched into the fibre core is limited by internal circuitry to a safe level, the safety precautions do not assume this.

Test Equipment

All optical test equipment used by Telecom is classified as class 1 and hence requires no special precautions. Never the less, for simplicity with operational and maintenance procedures, test equipment will be treated with the same precautions as line equipment. Therefore line staff are instructed not to joint or view fibres during testing operations.

SYSTEM SAFETY FEATURES

Facilities are incorporated into the optic fibre system to prevent hazards occuring to personnel due to the escape of Laser radiation from a broken fibre or uncoupled connector.

These facilities operate in the following manner:-

- A loss of signal at the receiver for longer than half a second will cause the optical transmitter for the opposite direction to turn-off or transmit a low-level signal.

- This loss or low level signal also results in the optical receiver in the other repeater to cause its associated transmitter to shut-down or transmit a low-level signal.

System Safety Features (Cont'd)

- Manual operation is required to return the optical sources to normal operation. If repair or reconnection has not been effected when the restoration attempt is made, the laser optical source must be switched off again within half a second.

- The system will continue to support operation of the order wire and supervisory signals up to and including the repeaters either side of the interruption.

LASER SAFETY REQUIREMENTS

Only staff who have attended an optical fibre training course and had their eyes tested (as per Telecom Eye Examination Form P443) may install, test and repair Optical Fibre Cables.

Note The optical power launched into the fibre core in the Telecom systems in a no-fault condition is limited by internal circuitry to a safe level. However, the laser may emit a dangerous level if this circuitry fails.

LASER SAFETY PROCEDURES

To ensure complete safety for all staff is achieved the following procedures must be observed:-

- UNDER NO CIRCUMSTANCES should an optical fibre, or connector that is connected to an optical source, be viewed directly with the eye or be directed at the skin.

Laser Safety Procedures (Cont'd)

- Ensure that the power is turned off at both ends of the section while the optical fibre cable is being worked on.

- In some circumstances it may be necessary to test fusion splices in conjunction with jointing operations. UNDER NO CIRCUMSTANCES must a light signal (from an OTDR) be transmitted through a fibre until jointing staff have completed splicing operations on the fibre and have notified the Testing Officer that it is safe to do so.

If measurements are being performed during splicing operations then as an added safety precaution reliable communications between jointing and transmission staff must be maintained in good working order.

- Viewing aids such as a microscope or magnifying glass must NOT be used to view the end of an optical fibre or connector that is connected to an optical source. If there is any doubt that a fibre or connector is energised, then leave it alone until it is confirmed that the fibre or connector is not energised.

- Any accidental exposure to LASER radiation is to be reported via P400, notated LASER EXPOSURE.

- Take notice of any Laser warning signs that may be displayed on the cable or on any equipment.

COMMON SAFETY

General Safety

Some safety features which are of a general nature and which are common to all work situations are covered in other handbooks. The features concerned are:-

- Heart-Lung Resuscitation
- First-aid
- Manual Handling and Lifting
- Manhole Rescue
- Heat Stress
- Normal Hygiene.

It is the responsibility of staff to read and apply them when applicable.

Common Safety Features "Non-Jointing"

The safety features that are common to both types of cable but are not related to the jointing of the cable are:-

- Manhole Testing - The testing of the manhole for dangerous gases with the appropriate "Gas Detector" and the subsequent removal of the gas, if any is found, before any personnel lifts a lid.

Common Safety (Cont'd)

- Manhole Guards - The erection of manhole guards around the manhole and/or the excavation to protect the public as well as Telecom employees.

- Roadway Signs - These signs must be erected where necessary to warn the public of Telecom works in progress. Refer Section D Linemens Handbook, Conduit and Cable Placement.

SPECIFIC SAFETY

The safety features peculiar to pressurised and filled cables are set out below.

Pressurised Cable

Freon - The use of "Freon" to fine tune the exact fault location must be used with care to prevent a hazardous situation occuring if, for some reason, any escaped Freon is accidently heated by a flame. This can cause noxious gases te be generated.

UC Closures - With respect to re-entering the Siemens Pressurisable UC closures it is important to:-

- release the pressurised air from any joint before it is opened to prevent accidents to the eyes etc.

- ensure that fingers etc. are kept away from the slit in the sleeve while opening it.

UC Closures (Cont'd)

- when installing the closures care must be taken with the cutting tool on the drill by ensuring that the rubber cap is on the cutting blade. Also remember to install the PVC tape over the end clamping band to avoid injury. For more details about these closures refer to the Linemens Handbook TPH 0057 EP "Jointing Junction and Main Cables" Section H.

Filled Cables

Cable filling compounds are safe to handle, however contamination with the eyes should be avoided.

Filled cable work will involve staff in moderate frequent hand washing to remove cable filling compound and therefore proper hand care should be taken. This involves the use of hand creams.

- Solvents

  Only Telecom approved cleaning solvents must be used at all times. When using solvents the following safety precautions must be observed.

  - Safety glasses and mittens must be worn
  - Solvents should be used in well ventilated areas and stored in suitable sealed containers and a policy of "No Smoking" be adopted when using the solvents
  - Skin contact with the solvents should be avoided by using "Non-Spill" dispenser bottles. (S494/51).
  - Avoid inhalation of the vapours.

Solvents (Cont'd)

- Ensure that no naked flames exist when cleaning cable sheaths with solvents. This is especially important when jointing inside vans as the enclosure could result in a build-up of fumes if the air-conditioning is not operating correctly.

Other Safety Features

Features appropriate to both pressurised and filled cables are :

- Fibre particles.

  Glass fibre off-cuts and particles can be difficult to locate using the unaided eye. Special care must be taken to dispose of all fibre off-cuts and fragments immediately after cleaving or cutting fibres.

  Fibre particles or off-cuts must be placed in suitable resealable plastic containers.

  Safety glasses S34/166, S34/56 or similar must be worn while cleaning, cleaving and placing bare fibre ends in the splicing machine. Safety glasses will give protection from "flying" fibre ends.

  Glass fibre offcuts are painful if they get into the skin and, if not removed immediately, may cause irritation or infection. They should be removed immediately with tweezers and the affected area washed thoroughly with water.

LOCATION OF OPTICAL SOURCES

Semiconductor laser diode sources are located in the following equipment: -

- Optical Line Terminal Equipment
- Optical Repeaters
- Stabilised Laser Diode Light Sources
- Optical Time Domain Reflectometers

Some types of optical power meters can be fitted with a light emitting diode (L.E.D.) for use as a calibrating source. Although the output from such L.E.D. sources is very much lower in power than that of a laser diode, all safety precautions should still be observed.

SIGNS, LABELS AND THEIR LOCATION

The signs and labels illustrated on Pages B-13 and B-14 are used in conjunction with optical line and testing equipment in the locations as listed below.

Area Caution Sign

An Area Caution Sign must be prominently displayed in the immediate vicinity of line Transmission equipment containing semiconductor laser diodes.

"Invisible Laser Radiation....." Label

- To be fixed to a front cover panel of Optical Line Terminal Repeater equipment located at about mid-rack height.
- Fixed to top surface test equipment containing laser diode sources.

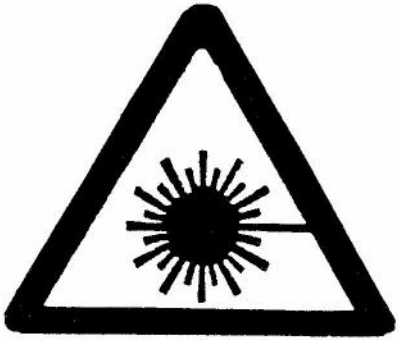
"Exposure to Class 3B....." Labels

- Fixed inside Optical Fibre Distribution Panels.

Aperture Labels

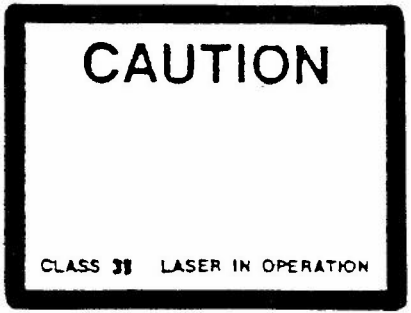
- To be affixed at optical connector or test points where disconnection of the connector may result in the emission of laser radiation.
- At or near to the output connectors of test equipment containing laser diodes.

Signs, Labels and Their Location (Cont'd)



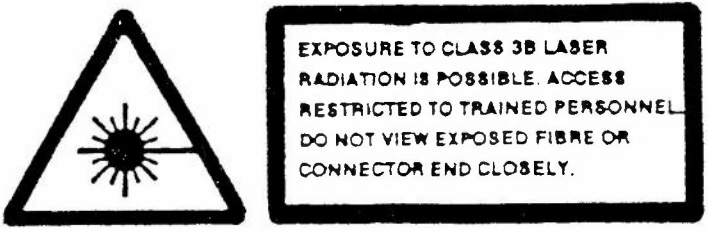
Colour - Black on yellow background

SIGN FACE S.148/189

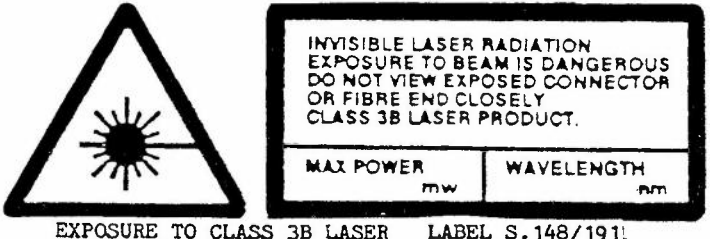


AREA CAUTION SIGN S.148/188

Signs, Labels and Their Location (Cont'd)



INVISIBLE LASER RADIATION LABEL S.148/190



EXPOSURE TO CLASS 3B LASER LABEL S.148/191

Reference: Laser Safety Procedures For The Installation and Testing of Optical Fibre Line Transmission Equipment. Issue 2, January 1983
TPH 2280 EP Optical Fibre Cable Operations and Maintenance Manual, Section 12.

Issue 1, 1987

SECTION C

TRAINING

- TEST EQUIPMENT
- TRAINING

TEST EQUIPMENT

External plant staff will not normally be required to operate test equipment. Cable fault location and acceptance testing will be carried out by staff from the Transmission Measurements Section.

TRAINING

Syllabuses will be available for external plant training courses covering the four basic areas - installation, fault procedures, maintenance and supervision. At least initially, splicing of optic fibres by fusion splicing will only be performed by installation staff. Maintenance staff will use mechanical splicing. Because of the difficulty of fusion splicing, the cost of the fusion jointing equipment, and the problem of retaining adequate skill in the process, it is not proposed at present to equip maintenance staff with fusion jointing machines. The training for maintenance and operation staff will therefore cover the procedures for fault finding and first-in-repair, routine maintenance (cable pressure systems, routine reports, security of routes and testing routines) and supervision.

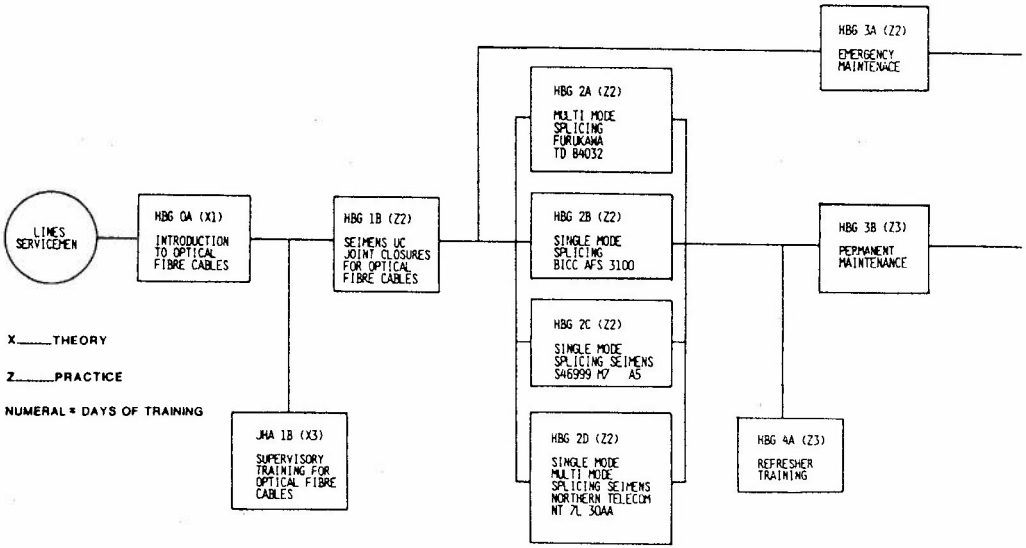
Supervisory Training

Training is available for Supervisors working with optical fibre cable and is available through module JHA 1B (X3). The module covers, safety, fault reporting, maintenance procedures, fusion splicing, joint closures, emergency cable repairs.

Training Module

A complete Module Flow Diagram is shown on Page C-4.

INTRODUCTION TO OPTICAL FIBRE CABLES | JOINT CLOSURES | SPLICING MACHINES | MAINTENANCE



MODULE FLOW DIAGRAM FOR OPTICAL FIBRE CABLE TRAINING

SECTION D

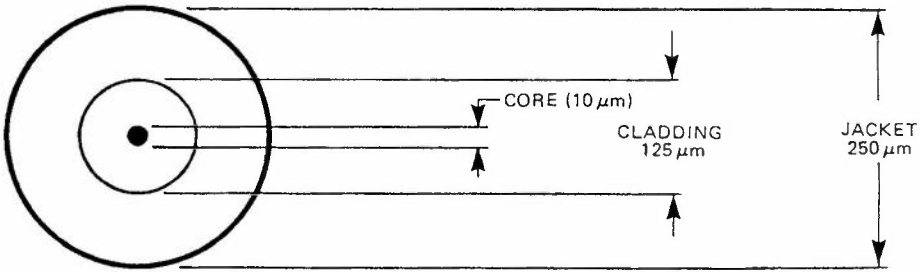
OPTICAL FIBRES - IDENTIFICATION

- SINGLE MODE FIBRE
- MULTI MODE FIBRE
- FIBRE COLOUR CODE
- UNIT IDENTIFICATION

Issue 1, 1987

Single Mode Fibre

Single mode fibres have a protective coating or jacket. The jacket protects the fibre surface from damage during such operations as cabling and installation. The jacket is removable using an approved stripping tool. The diagram below and the table on Page D-3 details the construction of single mode fibres.



SINGLE MODE FIBRE CONSTRUCTION

ITEM	DESCRIPTION	
Core	Material	Doped silica glass
	Mode field diameter	10 ± 1 micrometres
Cladding	Material	Silica glass
	Diameter	125 ± 3 micrometres
Protective Coating	Material	UV-cured acrylate
	Diameter	250 ± 30 micrometres
Maximum Mode field Concentricity Error		1.0 micrometre
Cladding Non-circularity		Less than 2%

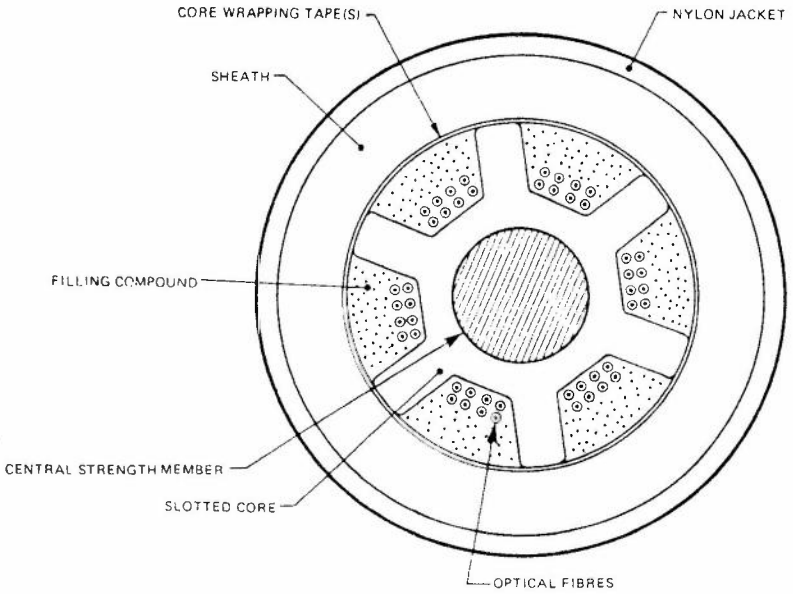
Single Mode Fibre Construction

Multimode Fibre

Multimode fibres are similar to single mode fibres except that the core is larger. The following table details the construction.

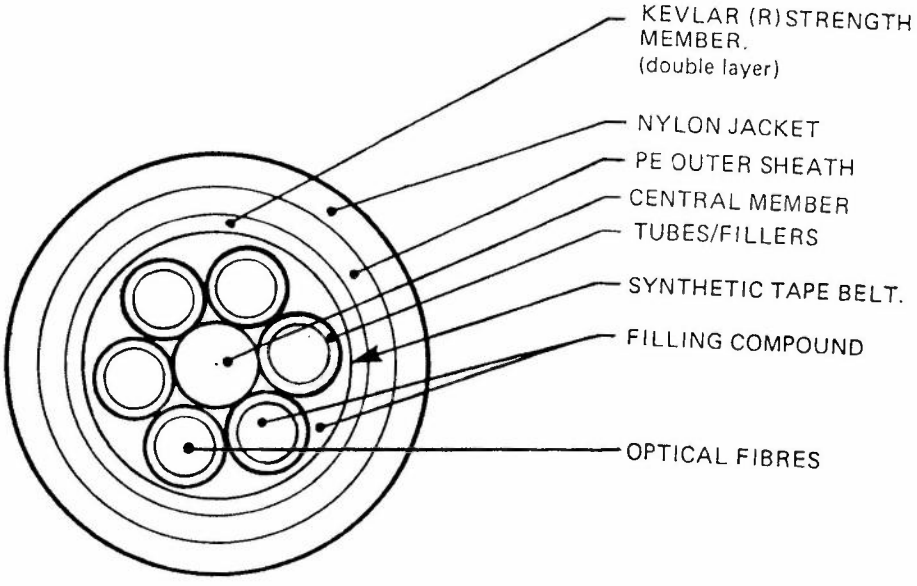
ITEM		DESCRIPTION
Core	Material	Doped Silica glass
	Mode field Diameter	50 ± 3 micrometres
Cladding	Material	Silica glass
	Diameter	125 ± 3 micrometres
Jacket	Material	U.V. cured acrylate
	Diameter	250 ± 3 micrometres

Multimode Fibre Construction

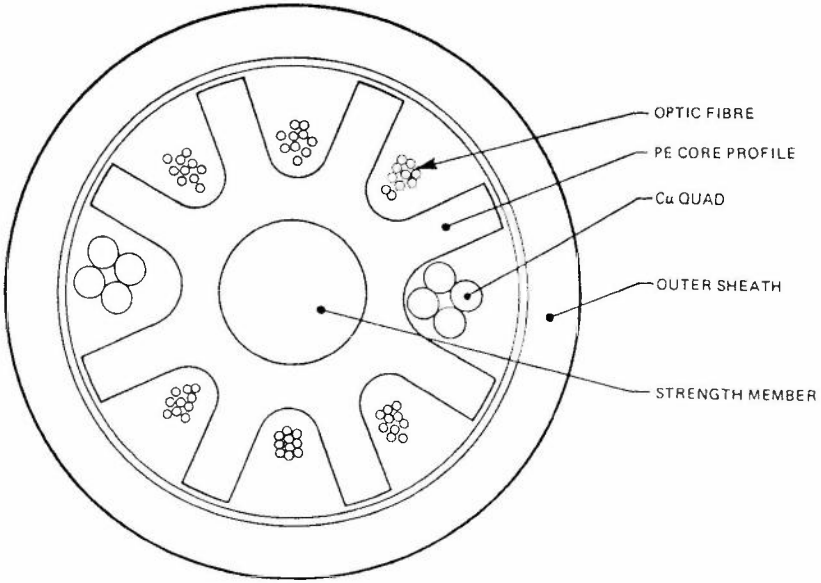


SLOTTED CORE CONSTRUCTION

OPTICAL FIBRES —IDENTIFICATION



LOOSE TUBE CONSTRUCTION



CROSS SECTION OF A PRESSURISED CABLE

FIBRE COLOUR CODE

All cables have a colour coding system that enables each fibre to be uniquely identified when the sheath is stripped and the fibres exposed for splicing or testing. Fibres are arranged in units and within each unit the fibres are uniquely coloured according to the following table.

Fibre Numbers	Colour
1	Blue
2	Orange
3	Green
4	Brown
5	Grey
6	White
7	Red
8	Black
9	Yellow
10	Violet

Unit Identification

The unit identification depends on the cable design.

- Loose Tube Design

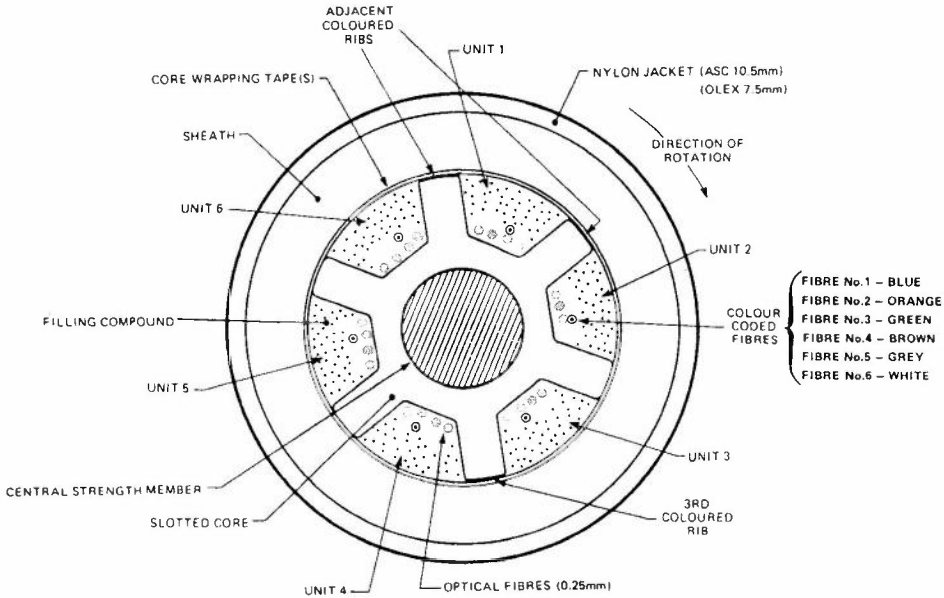
  A unit is a tube containing fibres and each tube is coloured according to the above colour code (so that the Blue tube is unit 1, the orange tube is unit 2 etc).

- Slotted Core Design (Including Pressurised Cores)

  A unit is a slot containing fibres. In this design unit one (slot one) is identified and the direction of rotation established by means of colouring three of the slot ribs. The diagram on Page D-10 illustrates the colour scheme.

Refer to TPH 0045 EP Optical Fibre Cable Installation, Section C for more details about Optical Fibre Cables.

OPTICAL FIBRES —IDENTIFICATION



Unit 1. is between adjacent coloured Ribs
Unit 2. is towards the third coloured Rib (Taking the shortest path)

FIBRE COLOUR IDENTIFICATION SCHEME

SECTION E

ROUTINE MAINTENANCE AND RESPONSIBILITIES

- MONITORING SYSTEMS
- ROUTE SURVEILLANCE
- STAFF RESPONSIBILITIES
- EQUIPMENT MAINTENANCE
  - BICC MODEL AFS 3100 FUSION SPLICING MACHINE
  - NORTHERN TELECOM NTLL 30AA FUSION SPLICING MACHINE
  - FURUKAWA FUSION SPLICING MACHINE
- FUNCTIONS AND DUTIES OF ROUTE SURVEILLANCE TEAM
- TOOLS, MATERIALS AND EQUIPMENT CHECK LIST

Issue 1, 1987

MONITORING SYSTEMS

System Alarms

All transmission equipment will be fitted with alarms that operate on the failure of the system. Resultant testing will establish and identify the cause of failure. These systems operate on a Go - No Go basis and do not provide information on gradual degradation.

Unfilled Cable

For unfilled cables under air pressure Cable Pressure Alarm Systems (CPAS) generally of the Automatic Pressurised Cable Monitoring System (APCAMS) type will be installed and will continuously monitor sheath integrity. CPA systems will also assist in identifying sheath fault location.

Filled Cable

For filled cables systems such as APCAMS are not necessary as the cable filling compound replaces air Fibre failure will be indicated by failure of the transmission facility and operation of the system alarm.

ROUTE SURVEILLANCE

Because of their importance to Telecom, route surveillance of significant and major trunk routes is an essential maintenance activity which should be performed to ensure their satisfactory and continued operation. It is designed to meet the following objectives :

- Maintain the cable in a suitable operational condition.
- Minimise potential fault conditions and activities.
- Facilitate cable fault location and restoration.

All Telecom staff can provide some form of route surveillance simply by observing activities near a cable route and identifying those which could cause damage.

Systematic route surveillance should be undertaken by skilled staff on a needs basis at frequencies determined by the Supervising Engineer (SE) or District Manager (DM) depending on route environment and importance.

In addition to CPA systems skills for unfilled cables, route surveillance staff must be able to locate transponders (refer to Section G) and perform emergency repairs to optical fibre cables. (Refer to Section J).

Route Surveillance

Route surveillance should normally be performed by an experienced Lineman with a suitable vehicle and equipment. An annual check inspection of buried cable routes by a Senior Lines Officer is also considered necessary to establish the effectiveness of the route surveillance techniques used. The function and duties of route surveillance are listed in Appendix 1 of this section. This should be considered as a check list only and detailed local instructions prepared to meet individual route requirements.

The primary activity of route surveillance is to physically check the cable route and apart from standard CPAS test equipment no special tools and equipment are necessary except for a transponder peg detector.

STAFF RESPONSIBILITIES

Cable Restoration Controller

In addition to the defined responsibility of specialist groups optic fibre cable maintenance requires a staff member to be nominated as the Cable Restoration Controller.

Cable Restoration Controller Responsibilities

The Cable Restoration Controller will be responsible for all logistics relating to fault location and repair of optical fibre cable faults. These responsibilities are preparatory for fault location/repair.

- Preparatory

  These responsibilities cover acquisition, maintenance and safe-keeping of all tools, material, repair cable, communication aids, test equipment, and mechanical aid acquisition, etc necessary for the external plant activities at the fault restoration site. Maintenance of staff skills, contact points, availability of outside equipment and assistance is also included.

  Maintenance manuals, referred to in some States as "Red Books", will contain necessary information for specific routes and systems. Pages E-16 to E-19 provide a list of tools material and equipment required. The Cable Restoration Controller must ensure that such items are readily available and in good order.

- Fault Location/Repair

  When an external plant fault occurs the Cable Restoration Controller or his delegate must have absolute authority of all activities at the fault site. He will decide on the course of action to be taken, nominate the external plant staff to attend, direct the activities of all staff at the site, including internal plant staff operating OTDRs. He will release designated optic fibre cable emergency repair equipment, arrange for other necessary equipment, accessories and support to be made available and attend to all other activities at the site. The Cable Restoration Controller shall decide the best place from which to direct activities which may not necessarily be the actual fault site itself. Contact must be maintained with the Line Section Control Station at all times.

NOTE : THE ABOVE PROCEDURE MAY VARY FROM STATE TO STATE. REFER TO SECTION 1 OF TPH 2280 (E) EP THE "OPTICAL FIBRE CABLE OPERATIONS AND MAINTENANCE" MANUAL FOR DETAILS.

EQUIPMENT MAINTENANCE

A variety of equipment is required to enable cable restoration to proceed without problems. This equipment ranges from mechanical aids to specialist fusion splicing machines.

It is essential that this equipment be well maintained and the maintenance procedures for most equipment is well documented and promulgated.

Fusion splicing machines maintenance is a delicate task and is generally not to be performed in the field. Maintenance by lines staff should be restricted to the following :

- General cleaning of the machine and its electrodes
- Replacement of fuses
  " globes
  " batteries
  " electrodes
- (Adjustment of fibre alignment
  " " electrode gap

NOTE : Any further maintenance or repair must be performed by the machine manufacturer.

Fusion splicing sets are precision instruments and should be handled with care. When not in use the cover should be in place and latched.

Maintenance & Adjustment - BICC Model AFS 3100 Fusion Splicing Machine

. Tool Wallet

A tool wallet containing enough tools for all simple routine maintenance is supplied with this fusion splicer.

. Cleaning

Electrode and 'V' groove cleanliness are vital in achieving consistently good splices and these should be cleaned on a regular basis.

. Checking Fibre Alignment

Before commencing splicing each morning, or after having moved the equipment to a new site, the angular alignment (parallelism) of the left hand fibre relative to the right hand fibre should be checked. This is absolutely necessary to ensure high quality fusion splices of the fibres.

. Electrode Gap Setting

The electrode spacing should be between 0.85 mm and 0.9 mm. As for fibre alignment the electrode gap is crucial in the performance of the machine. Care should be taken not to snap or chip the electrodes during the setting operation.

. Fuses

The splicer has two internal fuses. The charger for the batteries with a 1-0A, 1.25 inch fuse and the battery with a 2.0A slow blow 1.25 inch fuse. Failure of the splicer to function would indicate a blown fuse.

Maintenance & Adjustment - BICC Model AFS 3100 Fusion Splicing Machine (Cont'd)

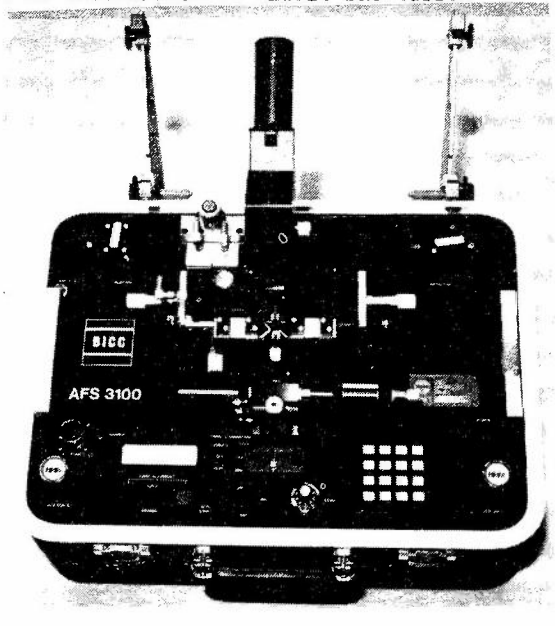
. Bulb Changing

The fibre illumination is by 12 volt 60 mA T1 type sub-miniature flange filament bulbs. It is essential that the fibre is illuminated to enable the fusion splicing process to proceed.

. Servicing

The maintenance procedures described above are the only service operations to be undertaken by field staff on the BICC AFS 3100. Under no circumstances should the unit be dissambled. For further service this machine must be sent to:

Austral Standard Cables
Whiteside Road,
CLAYTON,
VIC., 3168
Phone (03) 5441511



General Maintenance - Northern Telecom NTTL 30AA Fusion Splicing Machine (Cont'd)

This fusion splicing set is a precision instrument and should be handled with care. When the set is not in use, the cover should be in place and latched.

- Cleaning the Vee-Grooves
  Under no circumstances should any hard object be used to clean the vee-groove elements.

- Cleaning the Electrodes

  A white soot will normally build up on the electrodes with use. This should be removed periodically to ensure satisfactory operation.

- Replacement of Electrodes
  This operation is necessary whenever the electrodes become heavily pitted.

- Fuse Replacement

  The fuse ratings must be in accordance with the label on the set.

- Cleaning the LDM (Launch & Detect Modules)
  Cleaning must be performed in strict accordance with the documented procedures provided with the machine.

General Maintenance - Northern Telecom NTTL 30AA Fusion Splicing Machine (Cont'd)

. Servicing

The NTTL 30AA splicing machine contains no user serviceable parts. Under no circumstances should the unit be disassembled. Refer to Northern Telecom for service instructions of :

Northern Telecom (Asia) Ltd
2nd Floor
464 St Kilda Road
Melbourne
Vic 3004
Phone : 267 1397
34238
Telex AA 34238

NORTHERN TELECOM NTLL 30AA
FUSION SPLICING MACHINE

General Maintenance - Furukawa Fusion Splicing Machine

- The Furukawa splicing machine is a multimode splicing machine powered from battery packs or AC/DC power converters. Since this is a precision instrument great care is required during operation, and routine maintenance is essential.

- Replacement of the electrode assembly

NOTE : POWER MUST BE DISCONNECTED DURING THE FOLLOWING OPERATIONS.

- Replacement of the illuminating lamp

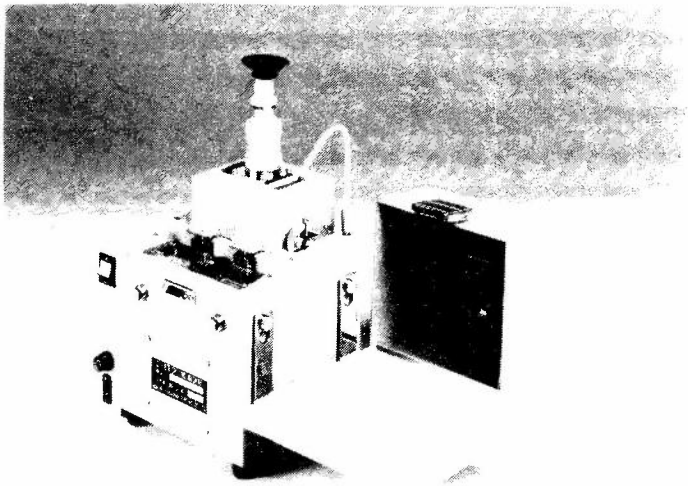
  - When the illuminating lamp fails to light up after the cover is closed it must be replaced with a new lamp.

- Fuse replacement

  If there is no power at the converter and the reset lamp fails to light up when mains power is on, then a blown fuse is the most likely cause and must be replaced.

- Battery charging

  When charging the battery case, correct connection of the equipment is most important.



FURUKAWA FUSION SPLICING MACHINE

FUNCTIONS AND DUTIES OF ROUTE SURVEILLANCE TEAM

FUNCTION	DETAILS	FREQUENCY
Inspection	. Watch for activities such as bridge building, drain excavation, Power Supply Authority activity, fencing, earth-works, surveying, etc.	Each visit
	. Look for excavations, flooding, subsidence, erosion, etc along route.	Each visit
	. Examine cables for possible crushing at manhole entry, check for corrosion of fittings.	Progressively
	. Check repeater buildings and sites for security, fencing, fire hazards.	Each visit
	. Check marker posts.	Progressively
	. Check access tracks, gates, etc.	Each visit

Functions and Duties of Route Surveillance Team (Cont'd)

FUNCTION	DETAILS	FREQUENCY
Communication	. Inform outside bodies working near cable.	As required
	. Check with Local Authority on proposed works.	As required
	. Report location, destination, activities and conditions along cable route to Section Control Station.	In accordance with Local Instructions
Servicing	. Monitor APCAMS information.	
	. Change air cylinders.	As required
	. Maintain supply of spare cylinders.	As required
	. Take air pressure readings.	Each visit
	. Test CPAS operation.	Progressively
	. Locate and repair air leaks.	Progressively
	. Replace missing cable markers.	As required
	. Locate and check transponders.	Progressively
	. Replace missing or unserviceable transponders.	As required

Fuctions and Duties of Route Surveillance Team (Cont'd)

FUNCTION	DETAILS	FREQUENCY
Recording	. Maintain log of incidents, activities and items requiring attention.	Each visit
	. Maintain log of cylinder usage and pressure readings.	Each visit
	. Amend/update plans and records.	As required.
Reporting	. Present log to Station Supervisor. Report fully on matters requiring attention.	After each visit

TOOLS, MATERIALS AND EQUIPMENT CHECK LIST

FUNCTION	DETAILS	
Instruments	. Multimeter APO No 2A.	
	. Cable locator.	
	. Transponder peg detector.	
General	. Portable motor alternator.	. LP gas lamps.
	. Tents and frames.	. Digging tools.
	. Tarpaulins.	. Backactor.
	. Spot lights.	. Water pump.
	. Fluorescent lights.	. Sludge pump.
	. Manhole guards.	. Warning signs.

Tools, Materials and Equipment Check List (Cont'd)

FUNCTION	DETAILS		
Emergency Cable	. Check air pressure in non-filled cable. . Check sheath for ultra-violet (UV) light degradation of cable stored in direct sunlight. . Check drums for physical deterioration.		
CPAS Equipment	. Air cylinders and fittings. . Pressure gauge. . Air leak location gear.		
Fibre Splicing Tools and Materials	Tool boxes.	Cleaving tools.	Butt hinges.
	Tweezers.	Fibre strippers.	No drip bottles.
	Shears.	Scissors.	Screwdrivers.
	Length of optical fibre cable.	Temporary splice closures and accessories.	GTE connectors.
	Polylayflat tubing.	Cable ties.	Cleaning pliers.
	Tension member clamps.	Acetone solvent.	Cleaning gauze.
	Dust away (compressed air) bottle.	Plastic bags.	PVC tape.
	Numbered fibre tags.		

Tools, Materials and Equipment Check List (Cont'd)

FUNCTION	DETAILS
Fibre Splicing Tools and Materials (cont'd)	Optical fibre ID labels.
	Hand cream.
	Mittens Polyethylene.
	Hand cleanser.
	Paper towels.
	Safety spectacles.
	UC Closure Material
Pair Splicing connectors/tools Tools and Materials	Approved waterproof
	Cable strippers.
Clips.	Continuity wire - termi-foil clips.

Tools, Materials and Equipment Check List (Cont'd)

FUNCTION	DETAILS
Communications	. Telephones, portable. . UHF radio. . VHF radio.
Information	. Route plans. Microfishe Viewers

Note: This check list does not contain the complete list of tools necessary for permanent fibre splicing.
Refer to TPH 0045 LC Linemens Handbook "Optical Fibre Cable Installation", Section G and H.

Reference : TPH 2280 EP "Optical Fibre Cable Operations and Maintenance Manual, Section 4

SECTION F

EQUIPMENT SPARES AND STORAGE

- STOCK HOLDINGS OF MAINTENANCE EQUIPMENT AND SPARES
- LOCATION OF MAINTENANCE EQUIPMENT AND SPARES
- RESPONSIBILITIES
- STORAGE CONDITIONS

INTRODUCTION

Spare jointing equipment and materials must be held at various strategic depots/locations to enable the rapid restoration of cables.

STOCK HOLDINGS OF MAINTENANCE EQUIPMENT AND SPARES

This will depend on the State organisation as detailed in TPH 2280 EP Section 1, Optical Fibre Cable Operations and Maintenance Manual. Consideration should be given to minimising stock but ensuring restoration targets can be met.

Below is a list of typical items which could be used for first in emergency repairs and includes the following items:

Serial/ Item No.	Item	Remarks	Qty
494/50	Fibre Stripper 0.25mm dia. fibre (single mode)	Tool to strip the coating layers off the fibre to expose the reference surface for cleaning and splicing	1
494/49	Fibre Stripper 0.90mm dia. fibre (pigtail)	" " "	1
494/48	Fibre Stripper 0.50mm dia. fibre (multimode)	" " "	1

Typical Standard Kit (Cont'd)

Serial/ Item No.	Item	Remarks	Qty
494/47	Loose tube cutter	Tool to cut the loose tube surrounding fibres to expose the fibres for stripping	
494/9	Cleaver	Tool to cut stripped fibre to length and to produce a finish on the end of the fibre suitable for fusion splicing.	1
494/8	Cleaver	Suitable for use with emergency and permanent splices for both SMOF and MMOF	
494/51	Solvent Container	A non-spill pump action container	1
509/37	Joint Closure re-entry	Equipment and tool kit required to re-close joint closure	1 Kit

Typical Standard Kit (Cont'd)

Serial/ Item No.	Item	Remarks	Qty
509/21	Consumable Materials	All consumable materials required to re-close joint closure	2 Packs
540/48	Gauze Pad	For cleaning stripped fibres	1 pack
494/12	Emergency splices 0.50 to 0.90mm fibre	For emergency restoration of fibre continuity prior to permanent repair of damaged cable	6 packs (5 splices per pack)
494/52	Transponder Peg Detector	Hand held unit to detect buried transponder pegs	1
509/10	End Caps with External Earth Terminal and Schrader Valve	For joints requiring external earthing or for use on pressurised cable	1 pack

Typical Standard Kit (Cont'd)

In addition, two lots of split conduits or an alternative method can be used for temporary joint closures to repair damaged cable as described in TPH1619. Emergency or interruption cable is also required.

A set of optical fibre cable cutters are needed and acetone for fibre cleaning which can be purchased locally in addition to paper towel required to clean filling compound off the fibres.

A kit of items required to carry out permanent repairs on a cable should include the following:

Serial/Item No	Description	Quantity
494/1	SMOF Fusion Splicing Machine	2
494/48	Fibre Stripper (0.400 & 0.500 mm)	1 of each
494/49	Fibre Stripper (0.900 mm)	1 of each
494/50	Fibre stripper (0.250 mm)	1 of each
494/11	Emergency splice 0.25 - 0.50 fibre	
494/8	Fibre cleaner	60
494/51	Cleaning Solvent Container	1
494/47	Loose tube Cutter	1
494/46	Buried marker tape	1
509/21	Splice Organiser Tray 2 x 300 mm	2 (S/pack)
509/47	Siemens UC 6/18 Enclosure	2
494/31	Transponder Pegs	25
494/32	Transponder Pegs	25
494/52	Transponder Detector	1

Serial/Item No	Description	Quantity
494/14	Splice Protector 0.25 to 0.25	
494/15	Splice Protector 0.25 to 0.9	3 packs of each item
494/16	(Splice Protector 0.9 to 0.9	(25/pack)
509/10	(Fusion Splicer System MMOF	2 packs (5/pack)

LOCATION OF MAINTENANCE EQUIPMENT AND SPARES

These items should be readily accessible and also be conveniently located within a District.

RESPONSIBILITIES

The Cable Restoration controller is responsible for the items in an emergency optical fibre repair kit or suitable officers should be delegated a similar responsibility for a permanent repair kit. Ensure that replacement items are obtained. In addition, all equipment and spares should be inspected and tested at least once every six months with any faulty items being immediately replaced. For more details refer to Section E "Routine Maintenance and Responsibilities".

STORAGE CONDITIONING

It is important that optical fibre emergency repair kits are stored inside a cool dry place.
In particular emergency splice connectors (GTE connectors) must be stored in a cool dry place away from direct sunlight.
Issue 1, 1987

SECTION G

FAULT NOTIFICATION ACTIONS AND LOCATION

- FAULT CAUSES
- FAULT INDICATION
- ACTIONS AND RESPONSIBILITIES
- FAULT REPORTING
- FAULT LOCATION
- OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)
- TRANSPONDER PEG DETECTOR

Fault Causes

Flow charts in this Section giving detailed step by step methods of dealing with faults are a guide only. However, it is important for staff to examine such flow charts to become familiar with their role in an emergency.

Possible causes of faults that require the repair of installed optical fibre cable include:

- Direct mechanical damage - backhoe, earth or fence stake, under-road borer, jackhammer, etc.
- Indirect mechanical damage - earth or bridge movement may pull adjacent cable lengths and damage joints, etc.
- Cable degradation - may be caused by faulty cable, either fibre and/or sheath, or faulty hauling or splicing practices, but may not develop to a significant extent for some years.
- Environmental damage - may be caused by manhole movement, rock movement, vibration from road and/or rail, rodents, other pests and chemicals (e.g. petrol) or corrosive/aggressive environments in conduits and manholes.

Fault Indication

The usual first indication of a serious fault will be loss of traffic on the route. Other indications of faults include observed damage, cable pressure alarm system messages and system performance indicators. Most reports of a serious nature will come from the Equipment Control Station.

Loss of System

Following the loss of a transmission system, technical staff must establish whether the system failure was caused by internal or external plant failure. This can usually be established with a high degree of confidence quite quickly, so that there is little delay before repair procedures start.

Observed damage

Damage may be seen by the regular route surveillance, other Telecom staff, a private contractor who may be digging "near" the cable or a member of the general public.

Damage to fibres will not always trigger transmission alarms because those fibres may not be in use at the time.

Cable Pressure Alarm Systems

Most optical fibre cables are filled cables which, are not pressurised with air. Some cables, however, particularly in urban areas and some of the earlier multi-mode cables, are air-cored and pressurised. Cable Pressure Alarm Systems (CPAS) on such cables can detect and locate sheath damage in the same way as metallic cables. If a transmission system alarm occurs as well as the CPAS alarm, cable damage can be assumed.

Air pressure alarm systems can not detect or locate fibre damage caused by stress or sharp bends. Optical Time Domain Reflectometers (OTDR's) are required for locating faults not caused by sheath damage, even if the optical fibre cables are pressurised.

ACTIONS AND RESPONSIBILITIES

Cable Restoration Controller

The first person to be advised of a cable fault will normally be the Cable Restoration Controller and in addition to the duties described in Section E, he now has the responsibility of controlling the repair procedure. He has the authority to call out staff, open stores and depots, hire mechanical aids and call in assistance as required.

As the duties of the Cable Restoration Controller will be critical when a cable fault affecting traffic has occurred, the following action is confined to that situation.

Repair Procedures

Because cable faults are likely to be variable, the procedures for repair staff will also be variable and flow charts describing the actions of each member of the repair team can not be prepared in advance to assist in the repair procedure. The best that can be done is to take a typical cable fault situation and nominate the steps needed to be taken to effect repair.

Flow Charts

On Page G-7 is a flow chart of a typical cable fault for a rural optical fibre cable where traffic loss shows that a cable fault in a length has occurred. The flow chart shows the various actions needed to be taken as further information on the fault because available.

Assume that the fault has been identified as being between two regenerator points and that the OTDR operator and external plant representative get to the near-side regenerator site at about the same time. While the operator uses the OTDR to locate the fault, the Cable Restoration staff continue along the route to the next regenerator site. They are in radio communication with each other. When the operator has an approximate location he advises the Patrolman, who then concentrates his examination of the route in that vicinity.

Should there be no evidence of mechanical damage in the vicinity of the fault location, the OTDR operator will then go to the other regenerator site to get a confirmatory location matched to the first. Should there be reasonable correlation between the two locations it will give the Cable Restoration Controller the confidence to replace a specific length of cable with assurance that the fault is within the replaced section. The next steps may be influenced by whether the fault has had a serious effect on traffic carried by the cable. If the effect on traffic is serious, then there is an urgency about repair which is likely to favour a temporary repair rather than a permanent one as it can usually be accomplished in significantly less time. It may also influence whether a more accurate, but time-consuming, OTDR location is attempted in order to reduce the amount of cable replaced.

Flow Charts (Cont'd)

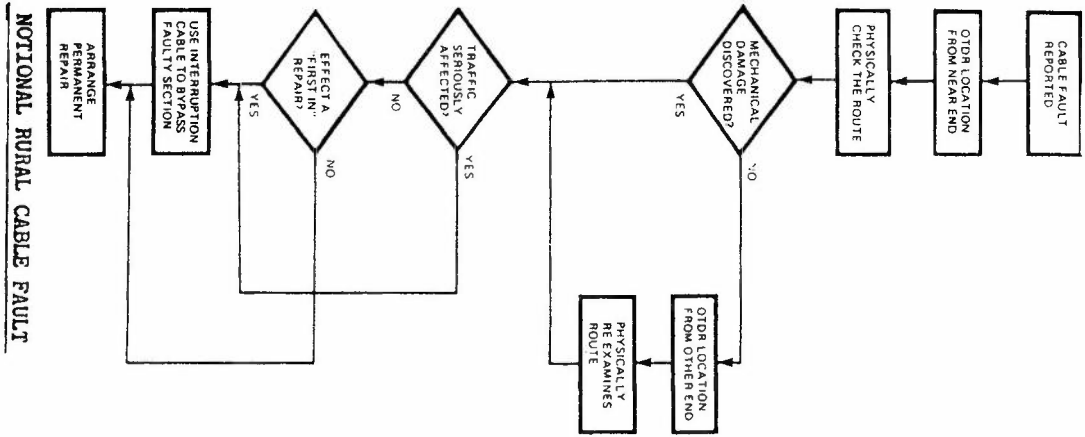
If the effect on traffic is not too serious, the loss may be tolerated until a permanent repair can be effected. This would avoid the need for temporary repairs. To cater for specific fault modes other flow charts are on Pages G-8 (Loss of System) G-9 (Observed Damage) and G-10 (Cable Pressure Alarm Systems).

Safety Aspects

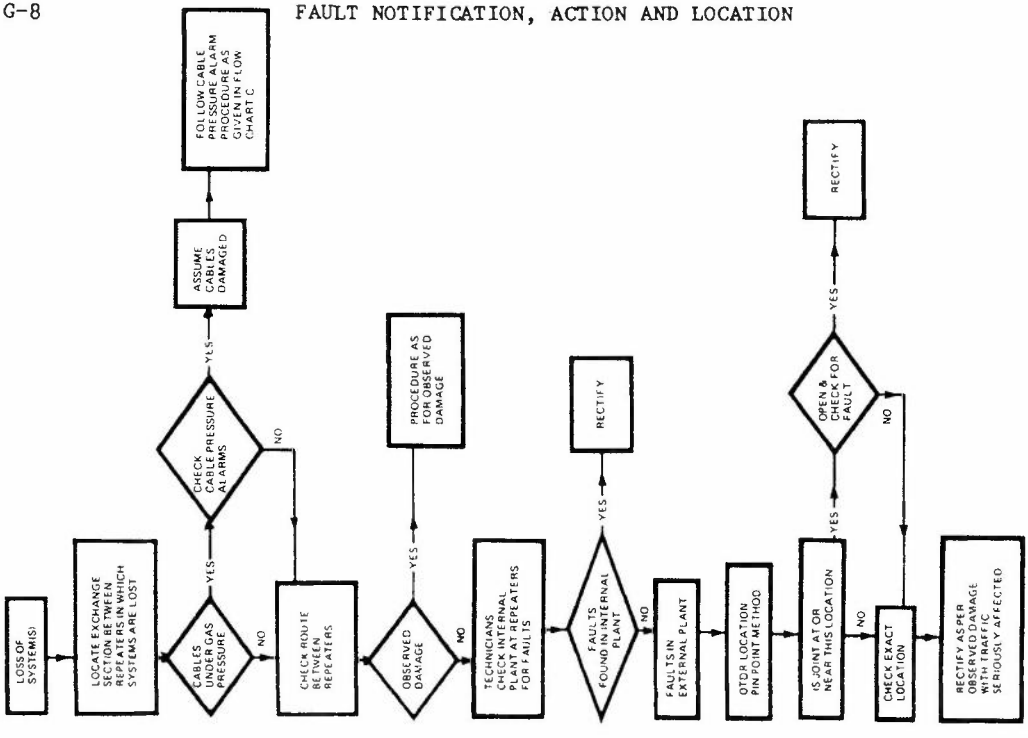
The Cable Restoration Controller must ensure that all safety aspects are satisfactory, including assurance that the laser source is disconnected from any fibres being worked on. It should be noted that most systems automatically shut down the laser source on both fibres of a pair when there is an interruption to a fibre and it requires manual reconnection by technical staff to reestablish the laser source. One of the responsibilities of the Cable Restoration Controller is to become familiar with the safety aspects, including laser safety, for all cable systems under his control.

Communications

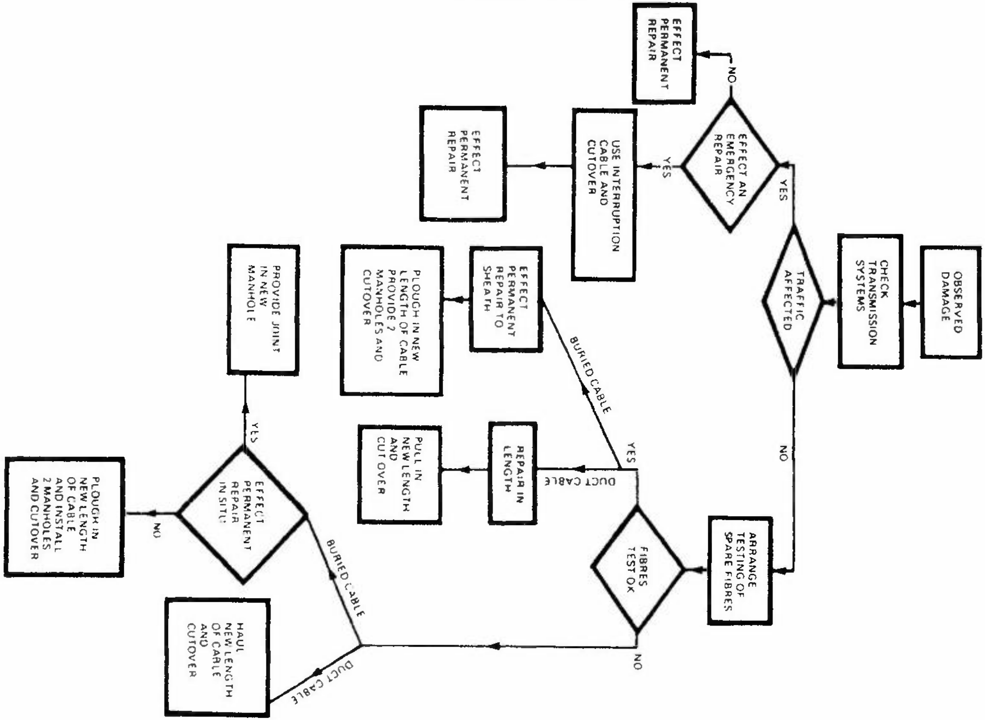
The Cable Restoration Controller must also satisfy himself that communications for all staff involved in the emergency are adequate. Section H-7 gives information on communications aspects.


CABLE FAULT REPORTED
OTDR LOCATION FROM NEAR END
PHYSICALLY CHECK THE ROUTE
MECHANICAL DAMAGE DISCOVERED?
YES
NO
OTDR LOCATION FROM OTHER END
PHYSICALLY RE EXAMINES ROUTE
TRAFFIC SERIOUSLY AFFECTED?
NO
YES
EFFECT A "FIRST IN" REPAIR?
YES
NO
USE INTERRUPTION CABLE TO BYPASS FAULTY SECTION
ARRANGE PERMANENT REPAIR
NOTIONAL RURAL CABLE FAULT

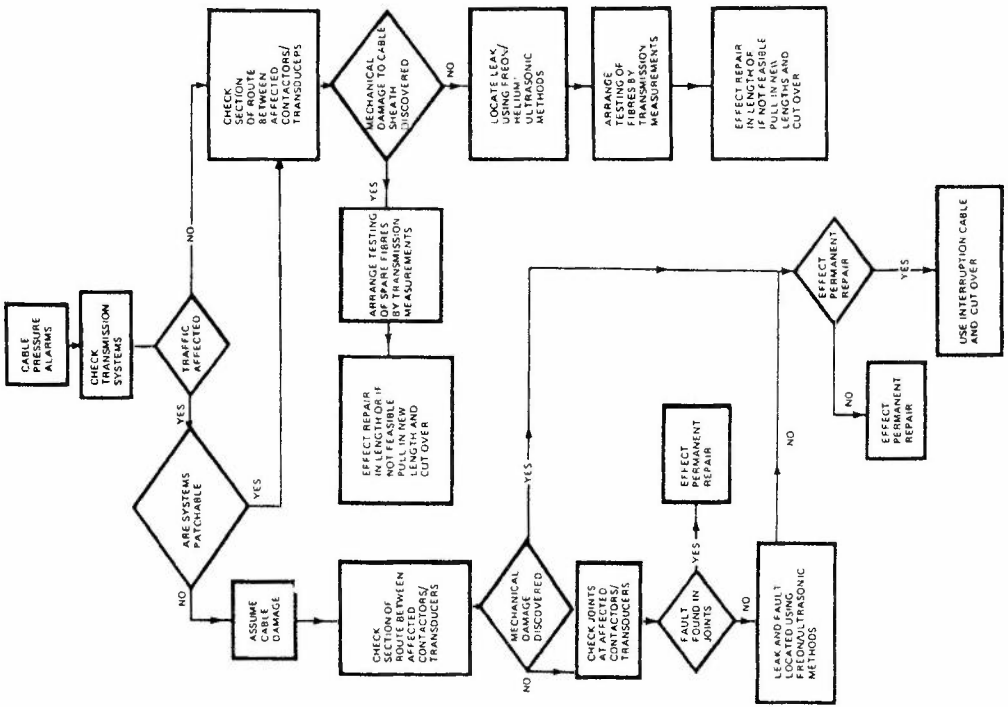
FAULT NOTIFICATION, ACTION AND LOCATION



OBSERVED DAMAGE



FAULT NOTIFICATION, ACTION AND LOCATION



CABLE PRESSURE ALARM SYSTEMS

FAULT REPORTING

This reporting procedure applies to all optical fibre cables regardless of type (multi or single mode), size or application in the network. All faults that occur in plant that is on the line side of the connectors at the end of the single fibre terminating tail, are to be reported. Faults in the section of the connector attached to the single fibre tail and faults in the actual connection are to be included. For copper pairs in the optical fibre cables, all faults on the line side of the termination point of the termination tail cable, including faults at the termination point, are to be reported. Reports are to be made out for all service affecting faults, non service affecting faults and incipient faults that have the potential for interrrupting service if corrective action is not taken. All cable pressure alarm faults are to be reported.

A report on each fault or incipient fault is to be prepared using the Optical Fibre External Plant Fault Report form E1245 an example of which is shown on page G-13. The report should be prepared in triplicate by the officer responsible for the repair work, as soon as practicable after service has been restored. The copies should be distributed as follows.

- 2 copies to the State External Plant area responsible for optical fibre cable system fault reports. The reports should be reviewed and the original, together with any additional comment that may be required, forwarded to:

  Operations Support Section
  Network Engineering Department
  Headquarters
  28th Floor
  570 Bourke Street
  MELBOURNE VIC 3000

Fault Reporting (Cont'd)

Operations Support Section will arrange for additional copies to be promptly forwarded to relevant areas at Headquarters.

- 1 copy to be retained by the reporting officer.

At the end of each financial year the reported faults will be analysed, and a report will be prepared at Headquarters. Copies of this report will be sent to each Chief State Engineer and to appropriate Headquarters Sections.

HQ INVOLVEMENT

Where a particular fault condition is believed to be unique and immediate repair is not necessary i.e., where patching is available, consideration should be given to avoiding any repair work until External Plant HQ staff have been consulted.

This will eliminate the possibility of crucial details relevant to the fault condition being lost or disturbed. The complete history of unusual faults is important in the ongoing development of optical fibre cable systems.

OPTICAL FIBRE – EXTERNAL PLANT FAULT REPORT

This form is to be completed for each external plant fault or incipient fault, including cable pressure alarm faults, repaired (refer TPH1363NO for further details).

1. CABLE ROUTE: .....
2. DATE FAULT DETECTED: .....
3. ROUTE SECTION and LOCATION .....
   .....
4. FAULT ☐ or INCIPIENT FAULT ☐
5. SERVICE INTERRUPTED ☐ or SERVICE NOT INTERRUPTED ☐
6. PLANT OUTAGE TIME: .....
7. CABLE DETAILS
   - Filled ☐ or Unfilled ☐
   - Single Mode ☐ or Multi Mode ☐
   - Number of Fibres: .....
   - Number of Copper Pairs: .....
   - Sheath Type: .....
   - Manufacturer: .....
   - Trunk.... ☐ or Junction.... ☐ or Customer .... ☐
8. FAULTY PLANT:
   - Cable ☐ Terminating Cable ☐
   - Cable Joint ☐ Connector ☐
   - Other Plant ☐ Details .....
     .....
     .....
     .....
9. DESCRIPTION and CAUSE of FAULT
   (Use Separate Sheet if necessary)
   .....
   .....
   .....
10. REPAIR ACTION TAKEN:
    (Use Separate Sheet if necessary)
    .....
    .....
    .....
11. REPORT PREPARED BY:
    - Name .....
    - Section/Branch .....
    - State .....
    - Telephone Number .....

HQ COPY 3

FORM E1245 (6/87)

FAULT LOCATION

Report

When a cable fault is diagnosed the Control Station advises the Cable Restoration Controller of the likelihood of a fault and in which regenerator section it is, and the identification of the system(s) affected. The T.F.M.C. (Transmission Facilities Maintenance Centre) is advised and radio and/or order wire communication procedures are established.

Cable Restoration Controller

The Cable Restoration Controller, is responsible for all of the logistics for fault location and repair of the cable fault. The Controller will nominate the jointers, tools, cable drums, material, excavation equipment etc. required on the site and the time required to attend the fault site. The Cable Restoration controller will stay in contact with the Control Station at all times.

Locating the Fault

Before any repair work can be carried out on the cable the fault must first be located. This can be done in a number of ways depending on whether the cable is pressurised or filled.

Route Inspection

Irrespective of whether the cable is pressurised or filled a route inspection, once cable damage is suspected, should always be undertaken immediately no matter what other location techniques are being arranged.

In urban areas the maximum distance between regenerators will be about 10 kilometres. It is likely that traversing the cable route will determine the location of damage much faster than other techniques.

Cable Restoration Staff may, from previous knowledge of works near the cable, be able to recommend the section of cable route for initial inspection.

Pressurised Cable

Any sheath damage will be indicated by transducers such as contactors and alarmable flowmeters connected to the cable which will indicate the section damaged.

The exact location of the fault can be determined by utilising freon techniques which are satisfactory for use on unfilled Fibre Optic cable.

Filled Cable

With filled cable, unless the ground has been disturbed, an OTDR will be necessary to pin-point the fault. An OTDR would also be used if there is any doubt about the location of the fault.

If, however, there is a copper cable along the same route then, there is a reasonable chance that this cable will also be damaged, the fault site may be located by using a Direct Reading Bridge or a Pulse Echo Tester.

Terminations/Pigtails S.494/26 to 45

If a fault is not obvious or easily located then it could be in the pigtail connected to the Optical Fibre Termination and Patching Modules in the exchange. The only way a fault in a pigtail can be determined is to use an OTDR which, however, is not accurate at such close ranges.

To overcome this problem there are two methods that can be used :-

- Use an OTDR either from a far exchange or the nearest regenerator or
- Insert a reel of fibre, which contains about 1km of fibre, between the connector and the Pigtail and then use the OTDR from the exchange where the fault is.

OPTICAL TIME DOMAIN REFLECTOMETER - (OTDR)

OTDR's are used to carry out tests some of which are :-

- Determine the distance to splices.
- The location of faults.
- The optical length of regenerator sections.

OTDR Methods - Fault Location

There are four fault location methods using an OTDR which will give a distance to the fault. The distance determined is a "fibre" distance and not the route distance over the ground. The "fibre" distance takes into account such lengths as the loops in manholes and pits etc.

The four methods are:-

- One-way only
- Two-way
- Modified Two-way
- Pin-point

For details about locating faults using OTDR's refer to TPH 1622 EP "Optical Fibre Cable Fault Location Methods Using An Optical Time Domain Reflectometer".

Fault Located

When the position of the fault has been determined by the OTDR operator the Cable Restoration Staff then travels along the route looking for signs of disturbance, concentrating at the estimated fault location.

It may be possible that an inspection of the total route or that part in the vicinity of the OTDR fault location does not reveal the cause of the fault. In this case further testing may be required to establish the likely fault location so that the repair decision can be soundly based.

Fault Located (Cont'd)

If after an OTDR location from the nearer regenerator site has been made and no evidence of mechanical damage is discovered, then the Controller must decide:-

- Whether to use a more accurate method to locate the fault so as to shorten the length of cable to be replaced, remembering the time to locate increases with better location methods or
- Whether to immediately nominate running out interruption cable to the nearest joints or
- Replace the faulty length.

Accuracy of the fault location is dependent on the accuracy of cable record measurements and on-site marker information. A wrongly marked post could, introduce a serious error into determining the fault location on site. In particular , spare fibre length at splice positions must be taken into account from the optical measurements, particularly if the fault is near one end of the cable length.

Exposing the Cable

Buried Cables

Once the position of the fault has been determined, even if only approximately, it may be necessary to excavate the cable at one or more positions for more accurate OTDR measurements or for installing an interruption cable or for cutting over the permanent repair.

Take care so as to reduce the risk of further damage to the cable during this operation.

Exposing the Cable (Cont'd)

In ploughed cables a plastic tape is installed above and in line with the cable at a shallow depth (about 800mm) so that it can be located to determine the exact line of the cable. However care must be taken when looking for the tape as sometimes it is installed close to the cable.

Marker posts fitted with plates show the location of the cable relative to the post, and transponders (refer to Page G-21 for details about using the Transponder Peg Detector for locating transponder pegs) which can be found accurately with a detector may be provided along the route.

These aids should be considered in any technique used to excavate around and expose the cable. A suggested technique is to use flags placed above the cable at marker positions (using the measurements stencilled on the marker plates) and another flag in the vicinity of the excavation site and align them to get the approximate line of the cable.

Then excavate across the line of the cable with either a mechanical aid or by hand until the plastic marker tape is found. Then with a knowledge of the line of the cable a longitudinal trench is made alongside and clear of the cable by a safe margin (a string line can be laid down parallel to the cable and separated from it by 0.5metre) and to a depth well below the cable.

To expose the cable the rest of the excavation must be done by hand, by first carefully scratching towards the cable on the wall of excavation with the spoil falling into the bottom of the trench until the cable is exposed and then continuing until the excavation is sufficient room for cutover, testing or examination.

Ducted Cables

With ducted cables the problem of route location is easier in that the duct run is normally well documented. However as the cable must still be exposed to effect the repair the ducts must be removed and therefore all precautions must be taken to prevent additional damage to the cable.

TRANSPONDER PEG DETECTOR S494/52

Operational Requirements

Adequate battery charge is indicated by a steady background tone when the detector is on.

If background tone becomes intermittent (i.e a beep every few seconds) the detector can only be used for another 10 minutes, when it will automatically shut down and must be recharged.

During set up, keep the detector well away from marker pegs.

For deeply buried marker pegs use the precise marker peg search technique. See Page .

A 12 to 14 hour battery charge will give about 6 hours continuous detector use.

Before using the instrument check the detectors battery state. Turn sensitivity switch clockwise to turn detector on. A continuous low tone should be heard. If not re-charge batteries.

After long periods of inactivity the batteries will not be fully charged. Always charge the batteries for at least 14 hours before extensive field use.

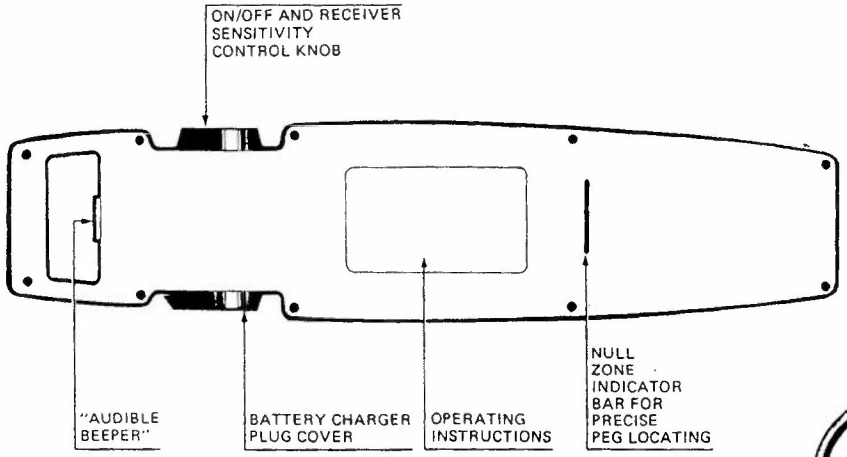
Locating Marker Pegs

Detector Set-Up

Before commencing a marker peg search, perform the following steps.

Rotate sensitivity control clockwise to turn detector on. A continuous low tone should be heard. If not re-charge the batteries.

FAULT NOTIFICATION, ACTION AND LOCATION



DETECTOR UNIT

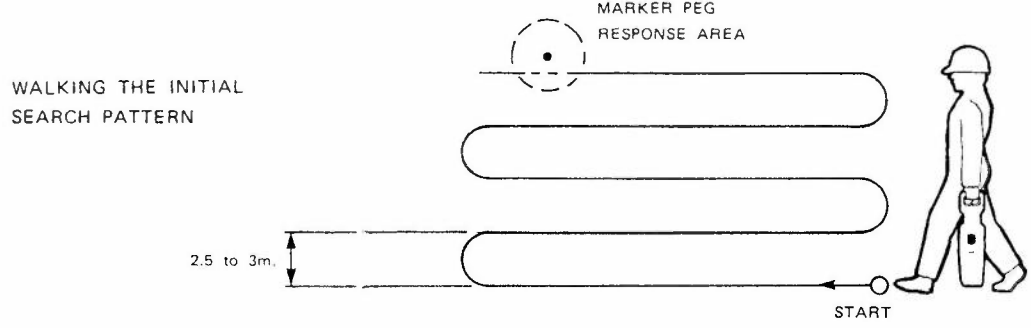
SENSITIVITY CONTROL SWITCH

Detector Set-Up (Cont'd)

- Turn sensitivity control fully clockwise. If a loud tone results turn control anti-clockwise until the loud tone disappears.

Locating the Marker Peg's Audible Response Area in an Unmarked Situation

To locate a buried marker peg's audible response area (which is a circle of diameter about equal to the depth of marker peg burial where the detector produces 2 beeps per second or a high tone) carry out the following steps. See Below.

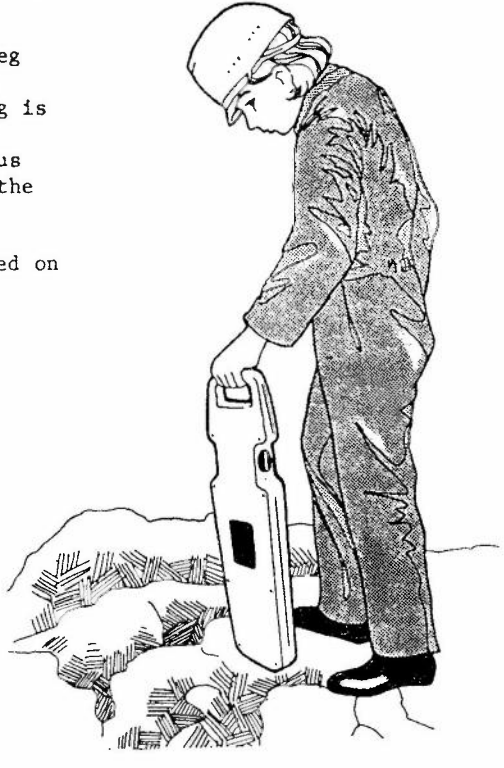


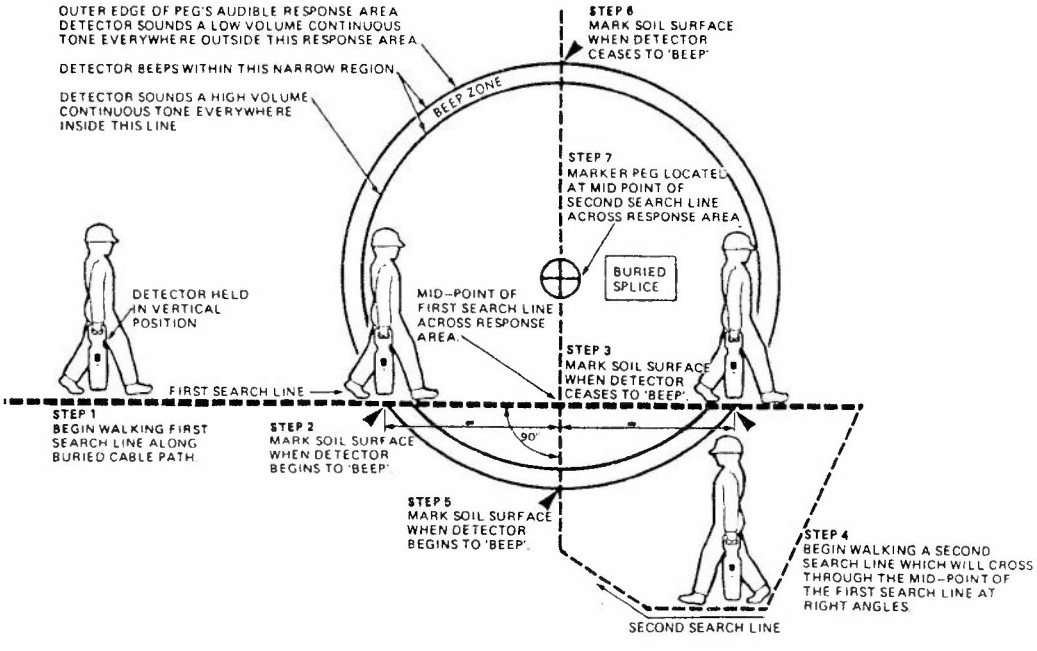
STEP 1: While holding the portable peg detector vertically at your side, walk in an initial regular search pattern with about a 1 to 3 m spacing between adjacent legs.

STEP 2: Continue the regular search pattern until the portable peg detector produces loud beeps which indicate the marker peg is nearby. Establish where the beeps lengthen or a continuous tone is heard as this means the marker peg is close.

STEP 3: Follow the procedure described on Page G-26.

DETECTOR UNIT IN USE





AUDIBLE RESPONSE AREA OF BURIED MARKER PEG

Locating The Marker Peg's Audible Response Area Along A Clearly Marked Cable Route

To locate a buried marker peg's audible response area (which is a circle of diameter approximately equal to the depth of marker peg burial, where the detector produces 2 beeps per second or a high tone), carry out the following steps as shown on Page G-25.

STEP 1: While holding the portable peg detector vertically at your side, walk a first search line along the marked buried cable path toward the desired location.

STEP 2: When the detector begins to 'beep', mark the soil surface and continue to walk in a straight line. After the beeps stop, the detector will sound a high volume continuous tone within the marker peg's response area.

STEP 3: As you cross out of the marker peg's response area, the detector will again begin to beep. Mark the soil surface where the beeping stops.

STEP 4: Begin walking a second search line which crosses through the midpoint of the first search line at right angles (i.e. 90°). Be sure to approach the first search line from outside the response area, as indicated by the detector sounding a low volume continuous tone.

STEP 5: When the detector begins to beep, mark the soil surface and continue to walk in a straight line along this second search line. After the beeps stop, the detector will sound a high volume continuous tone within the marker peg's response area.

Locating The Marker Peg's Audible Response Area (Cont'd)

STEP 6: As you cross out of the marker peg's response area, the detector will begin to beep again. Mark the soil surface where the beeps cease along this second search line.

STEP 7: The buried marker peg will be located roughly at the midpoint of this second search line.

Precise Marker Peg Location

CAUTION: Large metal objects may distort the location accuracy. Cars, trucks and mechanical aids should be at least 3 m away from the response area.

A null technique is used to precisely locate the buried marker peg within the response area found as described above. This is carried out by performing the following steps as shown on Page G-30.

STEP 1: While holding the portable peg detector horizontally at a constant distance above the ground surface, begin walking toward the centre of the buried marker peg's response area previously located. The detector will beep within the response area.

STEP 2: When the detector nulls, (beeps drop to a very low tone), mark the soil surface directly below the Detectors' null zone indicator bar. Continue walking in a straight line through the null zone. If a null zone is not located within the marker peg's response area, try each of the following:

Locating The Marker Peg's Audible Response Area (Cont'd)

- Hold the detector lower to the ground surface and retrace your original null zone search line,
- Reduce the detector's sensitivity by turning sensitivity control knob toward its minimum setting.

STEP 3: As you cross out of the null zone, the detector will beep, mark the soil surface directly below null zone indicator bar.

STEP 4: Begin walking a second null zone search line which crosses through the midpoint of the first null zone search line at right angles, (i.e. 90°). Be sure to hold detector horizontal at a constant distance above ground surface, similar to the first search line.

STEP 5: When the detector nulls, mark the soil surface directly below the null zone indicator bar. Continue walking in a straight line through the null zone.

STEP 6: As you cross out of the null zone, mark the soil surface directly below the null zone indicator bar.

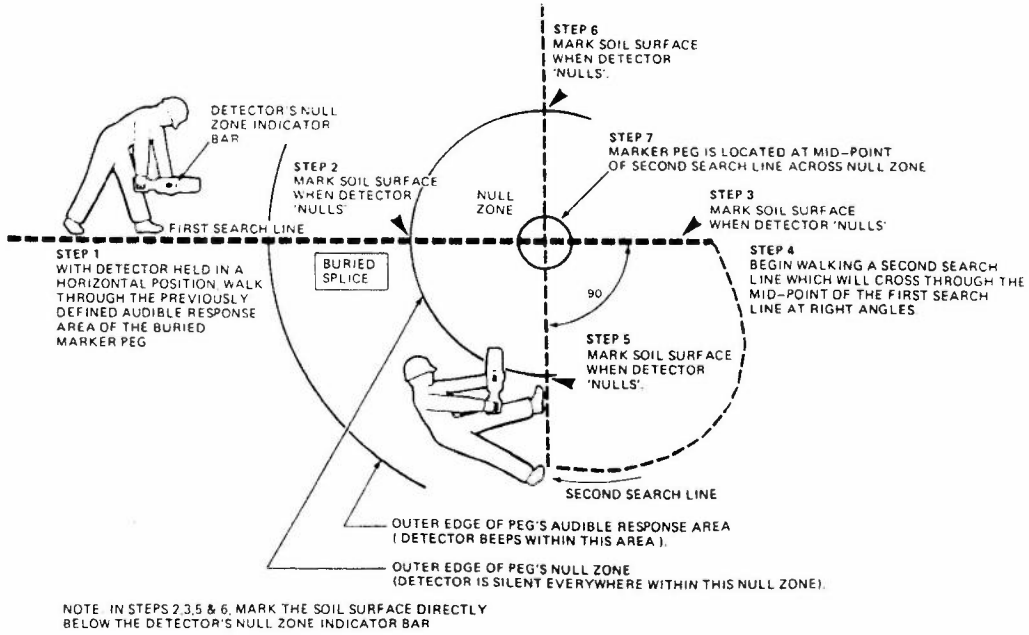
STEP 7: The buried marker peg is located at the midpoint of the second null zone search line.

END OF SEARCH

Once all marker pegs have been found turn detector off to conserve batteries.

CHARGING THE BATTERIES

- Turn sensitivity control switch off.
- Insert Amphenol plug of battery charger into the Detectors jack. Connect charger to a 240 volt AC mains outlet and turn on.
- The charger output is 1 ampere at 12 to 16 volts DC.
- Charge batteries for 12 to 14 hours. This will give about 6 hours continuous use.



NULL ZONE WITHIN AUDIBLE RESPONSE AREA OF BURIED MARKER PEG
- PRECISE MARKER PEG LOCATION

MAINTENANCE

No field maintenance is permitted.

Return faulty Detectors for service to the Australian Agent:

Anitech
241 Browns Road
Noble Park
Victoria 3174
Attention: Electronic Instruments

Note: Anitech is located in most States.

Detector: S.494/52 (Communication Technology U.S.A.) C9778, Marker Peg S494/31 and 32 (Colour White or Orange) C9779 (25 per box).

In some States repair centres may exist in the Lines Network Engineering Branch.

References : TPH 2280 EP "Optical Fibre Cable Operations and Maintenance Manual". Sections 6 and 7.

TPH 1363 NO "Optical Fibre Cables - External Plant Fault Reporting Procedures".

SECTION H

REPAIR TECHNIQUES AND OPTIONS

- COMPULSORY REQUIREMENTS
- RESPONSIBILITIES OF STAFF
- FIRST-IN EMERGENCY REPAIR
- CABLE CUTOVER SCHEDULE
- TERMINATIONS - FAULTS AND REMEDIES
- EMERGENCY CABLE
- TESTING AFTER REPAIR WORKS
- COMMUNICATIONS

COMPULSORY SYSTEM REQUIREMENTS

When the damaged cable has been located and the method of repair determined the next step is to repair the fibres. Before this can commence it is important that certain safety procedures be observed in relation to the laser feeding the fibres.

Laser Shut-Off

It is mandatory to have the laser power source disconnected before any officer handles the damaged fibres.

NOTE : Where an optical fibre cable has been damaged but not all the fibres are affected then it is permissible to work on the cable provided that at no stage are any of the undamaged fibres worked on or interfered with.

RESPONSIBILITIES

The responsibility for the safety of staff is shared by both the External and Internal staffs.

External Plant Staff

It is the responsibility of the Cable Restoration Controller or any officer nominated for the role to carry out the following procedures:-

Ensure that all External Plant staff engaged in the repair activities are fully aware of, and comply with, all safety procedures and precautions.

Ensure that the optical power is disconnected from all points feeding optical power into the fibres to be worked on in the cable section concerned.

External Plant Staff (Cont'd)

Ensure that a "hands-off" condition is observed whenever optical power is applied to the fibre being worked on, or at any time when a doubt exists.
Ensure that a "hands-off" condition is observed immediately if a communications failure occurs.

When all external plant work is completed, request and confirm the reinstatement of optical fibre patch cords. Sheath repair may be effected without the need to 'shut-off' the laser.

Progressively, as pairs of fibres are connected through, request restoration of laser feeding to check fibre joints and restore services. Sheath repair may be effected without the need to shut off laser feeding.

Technical Staff

The actual disconnection of the power from the laser is the responsibility of the technical staff at the closest optical power generator site on both sides of the fault i.e. either at a Terminal or regenerator.

The actual disconnection will take the form of:-

Disabling the laser feeding of the optical power to the faulty fibre in the direction of the fault. This may be automatic.
When requested by the Cable Restoration Controller, reinstate the laser feeding to check fibre connections and restore service if these are satisfactory.

NOTE It is important that at no time will technical staff perform any testing of the fibres without first ensuring that no other staff are working on the cable.

Restoration of Fibres

When the Cable Restoration Controller is satisfied that all joints are completed and that all personnel are clear of the fibres only then is the technical staff advised to restore power to the system. As fibres are through-jointed associated individual systems may be turned on.

For details about Laser Safety aspects refer to Section B of this handbook and also Section B in TPH 0045 LC Linemens Handbook, Optical Fibre Cable Installation.

Emergency repair is the first-in repair to a damaged cable to achieve rapid restoration so that the service has minimum outage time.

When services are disrupted the most important consideration is to restore service as quickly as possibly. Those in the best position should do whatever first-in work is possible until the formally delegated staff arrive to continue the restoration.

The delegated staff to restore the service on Optical Fibre cables is to be found in Section 1 of TPH 2280 (E) EP "Optical Fibre Cable Operations and Maintenance" manual under "State Organisation".

Reporting

All faults must be recorded and a report submitted. A reporting system has been prepared and documented in TPH 1363 - "Optical Fibre Cables External Plant Fault Reporting Procedures" as well as Section G of this handbook.

Fault Repairing

The method of repairing a fault will depend on a range of conditions such as:-

- Is the traffic on the route seriously affected or not.
- The site conditions in the vicinity of the fault (e.g water course washaway, civil works in progress etc.).
- Can long lengths of interruption cable be used or not, etc.

All of the above and any other relevant factors should be considered in the planning stage of the fault restoration so that the most effective method for the repair can be arranged.

Permanent Repair

Sometimes the first-in repair will become the immediate permanent repair. For example, at a location where a number of cables are damaged a permanent repair may take only a little longer time than a temporary repair.

Also where the damage to the cable is such that only a few fibres are damaged it may be possible to patch the affected fibres onto alternate bearers. This would make it possible to then move straight into the temporary repair.

First-In Emergency Repair Options

Once the fault has been located and proved to be in the external plant then there are two options that can be used to restore service and they are, piecing out and repair cabling.

First-In Emergency Repair Options (Cont'd)

One probable source of a fault could lie in the connector and associated pigtail. Because of this and the limitation of OTDRs in fault location in this area it would be advisable to first investigate the pigtail etc. and replace where necessary.

It is important that the terminology of various repair cables used to restore service is understood. The repair cables in question are :-

Emergency Cable

This cable is used solely for the purpose of restoring service to normal operation. This cable is the ultimate or "Second-in Repair" cable. In some instances this may be the original interruption cable used. It should not be confused with the term "Spare Cable"

Spare Cable

This is the drum of cable set aside in the initial cable order for the installation programme to be used to replace any damaged section of cable during installation. Once the route is completed this drum becomes an "Emergency Cable".

Interruption Cable

Used to temporarily restore service after a fault has occurred. This cable should be of 200-300 metres in length. This length of cable has the following advantages :-

- As fault locations using an OTDR in the one-way mode can have an error of 120m then this length of interruption cable enables the cable containing the fault to be bypassed.

- As urban manhole spacings are of 200 to 300m in length some benefit may be gained by housing the interruption cable joints in manholes.

- Allows moving of the final joint positions to more suitable locations.

Other Types of Interruption Cable are :

- Rapid Deployment Cable

  The rapid deployment cable which is a lightweight, high strength, low fibre count cable designed for use as an interruption cable in outback areas where there are not many obstacles to overcome such as high development, major roads etc. thus enabling the cable to be easily run out along the route and without the need to provide a lot of protection for the cable.

- Single Fibre Cord

  As well as the above cables that can be used for interruption purposes a single fibre cord or even a pigtail can be used to bridge the break in fibre to restore service.

Repair Procedure

Once a decision has been made by technical staff that it is not possible to restore service by patching, then the service must be restored by either:-

- Piecing Out

  This method would only be performed to restore service to top priority links.

  The procedure is to prepare both ends of the broken fibre for jointing as normal and then prepare a "piecing out" length of fibre for joining the broken fibres. The length of the "piecing out" fibre to be such that it will bridge the damaged section of cable. Using G.T.E. Elastomeric splices join the piecing out fibre to the fibres in the cable.

  Once all fibres have been joined in this manner the joints can be temporarily housed in an organiser tray and the lot covered in a temporary closure eg. 100m PVC pipe. Refer to Section I for details.

- Interruption Cable

  Where it is possible to expose the cable by excavating, for buried cable, or by pulling slack cable through ducts then the installation of the interruption cable can proceed by jointing this cable to the damaged cable. The joint locations of the permanent repair should be considered at this time.

Installation of Interruption Cables

Duct Cables

If the cable is pressurised then the initial step in first-in repair is to ensure that the cable is adequately covered by air cylinders to maintain the pressure in the rest of the cable. Once this has been accomplished the restoration can then proceed.

In some cases where it is impractical or inefficient to excavate the damage site to repair the fault, e.g. through river beds, under roads or near buildings, the interruption cable may be installed in an adjacent conduit and the faulty fibres then cutover.

If conduit space is not available, or the entire conduit route has been damaged, the interruption cable must be run above the ground. All attempts must be made to protect the cable and make it as secure as possible. This includes running the cable wherever possible in pipe and protecting the cable by careful placement (e.g. in the gutter) or using other mechanical means.

For duct cables a minimum length of 20m must be replaced. It is more likely however that a complete length of cable between manholes will need to be replaced.

Before pulling any slack cable through the ducts, it is important for the Cable Restoration Controller to know in which manholes the loops are located and also, that an officer has been despatched to free the loops. Adjacent joints should also be checked to ensure that cable movement has not adversely affected them.

Duct Cables (Cont'd)

Once the loops are free the cable can then be pulled through the ducts. It must be remembered that any pulling of cable is to be done by hand only and at no time should mechanical means be used as optical fibre cables have a low hauling tension of about 1kN, unless suitable equipment which provides an accurate indication of the hauling tension is used. Care is required in hand hauling as hauling tensions up to 400 N can be achieved. Care must also be taken to ensure that the cable is not hauled around a bend smaller than 250mm bending radius.

Buried Cables

For buried cable the normal situation results from faults which were easily located by visual means, such as those caused by machinery etc. The cable may be stressed and may need to be replaced for a minimum of 10m each side of the fault. This distance however, may not be enough because of the extent of the damage and if joints are located nearby the actual length must be based on common sense.

The reason for this length is to ensure that any damage propogated along the cable will be removed and unnecessary joints avoided.

Any excavation of the cable to achieve the 20m required must be undertaken with great care to minimise damaging the cable further.

The interruption cable is then run out and protected at vulnerable points along the length and placed into pits or manholes at each end. Interruption cable may already be equipped with connectors if so ordered at each end and it will then only be necessary at joint positions to take the affected fibres out and then insert into the connectors. If no connectors are fitted then the interruption cable and the damaged cable will both have to be prepared for jointing with the GTE mechanical connectors.

Buried Cables (Cont'd)

The jointing positions should be suitable for later placement of pits or manholes. If the interruption cable is the same as the original cable and it is intended to use this length for the permanent repair then sufficient slack, at least 15m at each end should be left.

If a mechanical aid is available on site for the temporary repair then use it to prepare for the permanent repair. However this should not jeopardise the earliest restoration of traffic.

As each fibre is jointed through advice must be given to the Control Station by staff at the regenerator or exchange so that an attempt can be made to re-establish traffic on the repaired fibres. Communications must be kept open until systems are operational so that re-splicing can be done if necessary.

Once the installation of the interruption cable has been completed arrangements must be made to ensure reasonable protection for the interruption cable and joints for the time between the temporary and the later permanent repair.

CABLE CUTOVER SCHEDULE

Permanent repair requires practices similar to initial installation work that is install a new length of cable and then joint to existing cable. This procedure is termed a cutover (permanent repair).

Before a cutover can proceed to effect permanent repairs on optical fibre cables, a cable cutover schedule must be prepared.

Critical Features of a Schedule

Essential features of a cutover schedule are the identification of the key personnel involved and the significant information which must be known to all involved before the work can proceed. The schedule must be performed in accordance with the duties and times specified by the Transmission Facilities Management Centre (TFMC).

These critical features are :

- the person responsible for preparing the schedule
- the person responsible for the field co-ordination of the work
- the date of the cutover must be known to all responsible groups
- the location
- Project and Authority No. for appropriate authorisation
- Distribution of the schedule to all responsible groups.

For full details about jointing and sealing enclosures on new UMMB multimode, fusion splicing single mode and jointing FNPEHJ type optical fibre cables refer to TPH 0045 EP Linemens Handbook "Optical Fibre Cable Installation". Refer to Section I of this handbook for details about emergency repair splicing of Optical Fibre Cables.
Refer to TPH 2280 EP "Optical Fibre Cable Operations and Maintenance manual, Section 9 for details about cutover schedules.

TERMINATIONS - FAULTS AND REMEDIES

To assist in the quick repair of fibre faults in termination modules the following sequence of investigation/repair action is recommended and is presented in descending order of preference :

- Examine connector to through-connector interface for 'poor connection' or fibre break at connector entry. Repair as appropriate.
- Examine cable layout for sections where bend radius is severly reduced or stress is imposed on cable/fibre such as at cable ties, and in protection tubes. Relieve bending and stress as appropriate.
- Examine fibre to pigtail joint and re-make if 'broken' or suspect (obvious flaw visible).
- If no obvious causes can be seen replace the pigtail.

EMERGENCY CABLE

- Location

The prime requirement for the storage location of Emergency Cable is accessibility at the time of fault occurrence. However, closely behind this requirement is the preservation of the quality of the cable. High temperatures are a hazard to the plastic materials within the cable and temperatures which can occur in vehicles may cause deterioration. It is recommended that emergency and interruption cable generally is kept in a secure, shaded and well ventilated environment. An exception may be for routes that have patrolmen, where a relatively short length of cable, say 200 metres, may be kept with all other repair materials and tools in the Patrolman's vehicle. On other routes and for other lengths of interruption cable, the cable may be stored in a line depot or exchange, and the following additional points should be noted:

Emergency Cable (Cont'd)

The first-in repair team and the Fault Site Controller are aware of the location and have access to the location at all times.

The cable has adequate security and is clearly labelled so that it cannot be used by unauthorised personnel.

The Cable Restoration Controller has full details of the cable, i.e. type, fibre count, last test date, length, etc.

. Labelling

All interruption and emergency cables are to be labelled to show 4 separate groups of information :

- a warning to indicate the cables dedicated purpose and the contact telephone number of the responsible officer (Cable Restoration Controller).
- full cable description showing sheath code, construction, fibre count, mode, quality and fibre jacket diameter.
- a brief summary of Transmission Measurements test data when available.
- date of initial provision or changeover, last inspection and last test, if any.

The information in the first three can be placed on durable label/tag, whilst the date information should be on a separate replaceable tag.

Testing

All cables, both interruption and emergency, should be inspected every two years and tested for continuity if there is any evidence of mechanical damage. If the cable is pressurised a check of the pressure should be made every six months. Interruption cable which is to be reused should be tested after each use. The date of the tests should be recorded on the cable with a tag.

TESTING AFTER REPAIR WORKS

Testing of optical fibre cables after repair works have been performed can be split into two categories:

First-in Emergency Repair

In general no testing is required after these repairs. If the systems still will not operate after this type of repair, remake the joint. If the system still fails to operate then Measurements will need to be made using an O.T.D.R. to locate the fault. The accuracy of fault location using an O.T.D.R. and the 2-way location method is $\pm$ 40 metres.

Permanent Repair

After permanent repairs, it is essential that the cable be brought back as close as possible to its original specification. Each fibre should be tested after it is cutover but before it is put back into service. Refer to the Optical Fibre Cable Operations and Maintenance Manual Section 9 for test specifications.

Staff involved

In the event of serious cable damage, staff involved will range from the Cable Restoration Controller to the Lines Assistant doing the excavation work. Efficient and rapid repair can only occur if staff have effective communications. For example, as soon as the OTDR fault location has been completed, other staff must immediately go to the suspect location to examine it for evidence of cable damage.

Under emergency repair situations, all of the people involved may at one time or another need to communicate with each other.

Radio Communications:

Staff involved in the emergency will mainly rely on radio communications for their needs. Some staff will, in addition, have access to the dialled network while others will use the system order-wire. Some staff will require communications over short distances while others will need it over long distances. For example, the Cable Restoration Controller may be in his office communicating with staff at the fault site, many tens or even hundreds of kilometres away, while at the fault site communication may be required between people only hundreds of metres apart.

As a general rule, for close communications the UHF mobile radio system will be used, while for longer distances the HF/VHF system will be used. Both systems may need to be available to most staff involved in the emergency.

Setting up the Communications Network:

When the organisation structure for emergency repair has been determined and all staff likely to be involved are identified and their roles and responsibilities defined, the communications requirements can be nominated according to the need. Usually Depots, Stores and Contractors, etc. can be reached by telephone and may not require radio facilities but there may be a special case where direct contact via radio may be justified, for example between the Cable Restoration Controller and Store to ensure the correct material is despatched to the fault site.

Some skill in operation is required, particularly for HF Radio, and staff should be encouraged to regularly use the facilities in their routine work to develop such skill.

Reference : TPH 2280 EP "Optical Fibre Cable Operations and Maintenance Manual Section 9,

SECTION I

EMERGENCY REPAIR SPLICING OF OPTICAL FIBRE CABLE

- CABLE FAULTS
- FAULT LOCATION
- SAFETY PRECAUTIONS
- G.T.E. ELASTOMERIC SPLICES
- METHOD 1 : REPAIR PROCEDURES USING SIEMENS JOINT CLOSURES
- METHOD 2 : REPAIR PROCEUDRES USING SPLIT CONDUIT
- ACCEPTANCE TESTING OF COMPLETED SPLICES

Issue 1, 1987

CABLE FAULTS

Faults on optical fibre cable may be separated into three categories :

- Failure of sheath or joint closure integrity, causing loss of air. (Not applicable to filled cable).
- Fibre failure where the number of faulty fibres does not exceed the number of spare fibres.
- Fibre failure where the number of faulty fibres exceeds the number of spare fibres.

If the first type of failure occurs, then repair methods will be similar to normal sheath or joint closure repair methods.

For the second type of failure where there are adequate spare fibres, then the circuits may be transferred to the spare fibres until the fibres can be permanently repaired by fusion splicing as a planned outage. There is no need to re-enter the cable or closure, as the circuits are patched at the exchange or repeater site.

When the number of faulty fibres exceeds the number of spare fibres available, emergency restoration procedures as described in this Section, or a variation of these instructions, will be necessary.

FAULT LOCATION

Faults Found Visually : For faults that are easily located visually the cable must be replaced for at least 20 metres either side of the fault. This will ensure that any damage along the cable will be removed and there is enough slack cable for entry into the jointing vehicle The required 40 metres (20 metres each side) may be obtained by;

- Pulling excess cable through ducted systems, from adjacent manholes.
- Excavating the cable for the required distance and patching in an interruption cable.
- Patching an interruption cable between manholes.

Location Using an OTDR (Optical Time Domain Reflectometer) : For faults that cannot be located visually an OTDR will have to be employed. TPH 1622 EP "Fault Location Methods Using an Optical Time Domain Reflectometer", describes the various methods of fault location.

SAFETY PRECAUTIONS

In addition to all normal safety precautions, extra precautions must be taken at all times while working on operational optical fibre cable systems.

The Cable Restoration Controller or his delegate is to be in communication with the exchange or repeater sites on either side of the joint. This is to ensure that no optical systems or measurement equipment are operating over the fibres being repaired. (Note, for emergency repair procedures only, once a fibre has been repaired, optical transmission may be resumed on that fibre.) No terminal or repeater equipment is to be energised without authority from the Cable Restoration Controller at the repair site. For further safety details refer to Section B of this handbook.

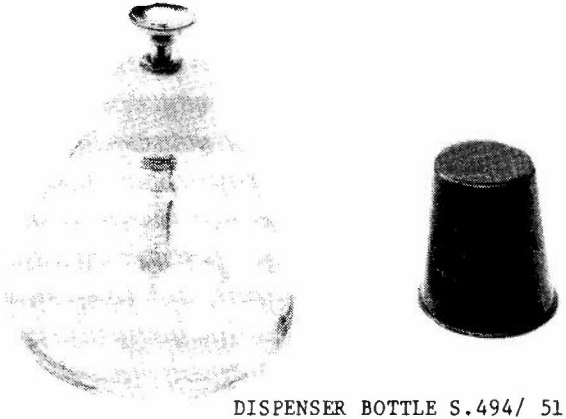
Safety Precautions (Cont'd)

Glass fibre off-cuts and particles can be hard to locate using the unaided eye. Special care must be taken to dispose of them immediately after cleaving or cutting fibres.

Fibre particles or off cuts must be placed in suitable resealable plastic or glass containers.

Only approved cleaning solvents (acetone, Isopar-H, Isopropyl alcohol, or Eucalyptus oil) must be used.

Cleaning solvents are volatile and flammable. Use only in well ventilated areas and store in suitable sealed containers such as a pump-action dispensing bottle (S. 494/51). Do not smoke while using these cleaning solvents.



DISPENSER BOTTLE S.494/ 51

Safety Precautions (Cont'd)

Safety glasses must be worn during cleaning, cleaving, and splicing operations on optical fibres. Safety glasses give eye protection from both solvents and glass splinters. If eye injury occurs, refer to ETP 0500 "First Aid" handbook for treatment. Safety glasses S.34/166 or S.34/56 or similar are suitable.

SAFETY GLASSES S.34/166

The correct tools must be used at all times while working on optical fibre cables. All tools must be kept clean and in good working order.

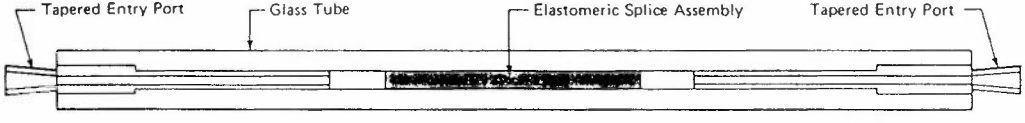
Do not look into the end of an optical fibre if a light signal is being transmitted. Doing so may cause eye damage.

Optical fibre ends are painful if they get into the skin. If not removed immediately, they may cause irritation and/or infection. Remove any fibre ends immediately with tweezers, and wash the affected area thoroughly with water.

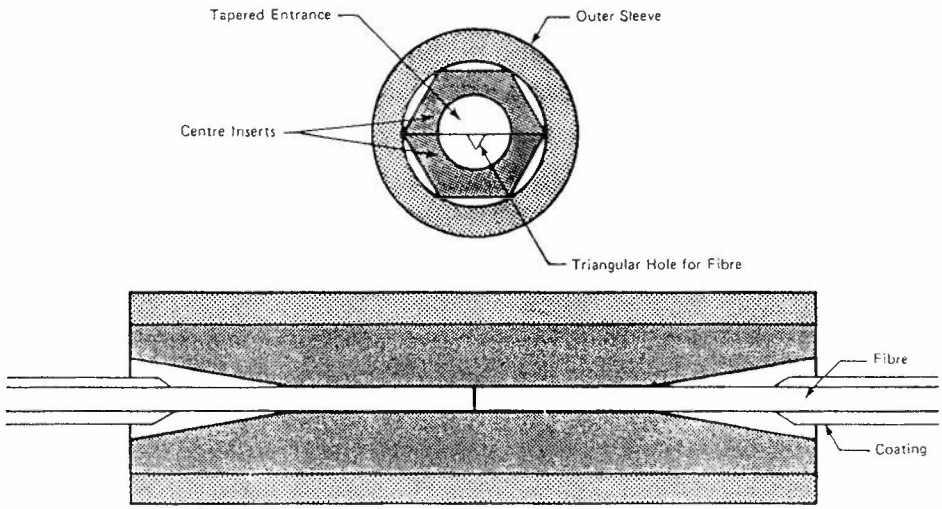
G.T.E. ELASTOMERIC SPLICES (S. 494/11 & S. 494/12)

Three splices are available, S.494/11 - GTE part No. WO 1098 - for 0.25mm to 0.40mm fibre coatings, S.494/12 - GTE part No. WO 1091 - for 0.50mm to 0.90mm fibre coatings and S.494/53 - GTE part No. 1096 - for 0.25mm to 0.90mm - fibre coatings.

The three splices are identical with the exception of the entry ports, which vary in size to accommodate the variation in fibre coating sizes.



SPLICE ASSEMBLY



ELASTOMERIC SPLICE

G.T.E. Elastomeric Splices (Cont'd)

The function of the elastomeric splice is to align two fibres to a common centreline. They consist of two centre inserts and an outer sleeve. When the two parts are mated, they form a triangular cross sectional hole into which the optical fibres are inserted. Once inserted the fibres are held and aligned to a common centreline.

G.T.E. Splice Procedures.

To splice two fibres together, insert a well cleaned and cleaved fibre to about the half way point of the elastomeric splice. Then insert another properly cleaned and cleaved fibre, into the opposite end of the splice and push it forward until the contact resistance of the first fibre is felt, so completing the splice.

METHOD 1 : REPAIR PROCEDURES USING SIEMENS UC JOINT CLOSURE

Materials and Tools Required: The following materials and tools are required for one temporary repair splice.

Siemens UC 6/18 joint closure with Schrader valve, for use with fibre count cables of 7 or larger. (S. 509/47)
Siemens UC 6/9 joint closure with Schrader valve, for use with fibre count cables of 6 or less. (S.509/46)
Siemens closure installation kit S.509/34
Siemens closure re-entry tool kit S.509/37
Re-entry kit S.509/21
GTE mechanical splices (S.494/11, S.494/12 or S.494/53)

Materials And Tools Required (Cont'd)

Cleaning pliers. Made from bent duckbill pliers (S457/4) by covering the jaws with felt cloth. Used for wiping down fibres with acetone.

Continuity wire (S433/212 284 or 285). (Required only for metallic cables with moisture barrier sheath.)

Cable cutters. Suitable for the cable being repaired.

Cable sheath stripper.
MHJ (S.459/155) or other suitable sheath stripper for optical fibre cable.

Fibre stripping tool.
S.494/50 for 0.25mm fibres,
S.494/48 for 0.40mm to 0.50mm fibres
S.494/49 for 0.90mm fibres.

Fibre cleaving tool.
S.494/8 for 0.25mm to 0.40mm Singlemode or Multimode fibres.
S.494/9 for 0.50mm to 0.90mm MULTIMODE fibres ONLY.

70mm door hinge. Rubber coated on inside faces to hold fibres during stripping and cleaning operations.

Acetone. For cleaning stripped fibres.

Cable cleaning pads (S433/264). For cleaning cable sheath.

35% Eucalyptus oil, for cleaning filling compound from cable core.

Materials And Tools Required (Cont'd)

A length of suitable optical fibre cable or fibre for the repair operation.

Suitable clamp or crimping sleeve and crimping tool for the tension member of the damaged cable.

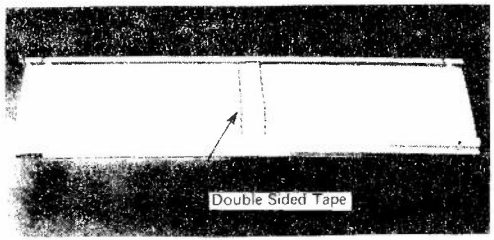
Ground sheet or tarpaulin for use as a clean working surface.

Suitable, numbered fibre tags.

Fast setting silastic adhesive or super glue.

Optical Fibre organizer kit. The kits come complete with all necessary hardware to break out fibres from the cable to enter the organiser trays and house fibres

Northern Telecom QNC1A	8 inch	S.494/18
Northern Telecom QNC1A	12 inch	S.494/19
Northern Telecom QNC1A	16 inch	S.494/20
Northern Telecom QNC2A	12 inch	S.494/21
Northern Telecom QNC2A	16 inch	S.494/22
Northern Telecom QNC3A	12 inch	S.494/23
Northern Telecom QNC3A	16 inch	S.494/24
Northern Telecom QNC4A	16 inch	S.494/25



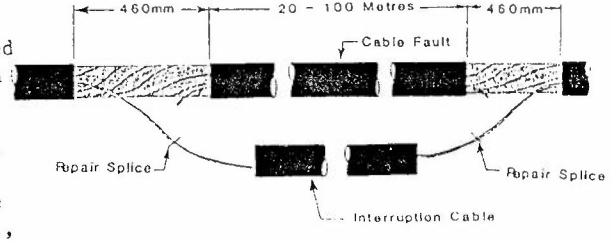
NORTHERN TELECOM ORGANIZER

Cable and Sheath Preparation:

Cable preparation may be approached in one of two ways.

If cable damage is extensive, then the appropriate length of cable is removed. If the cable is in a duct system and there is enough slack in adjacent manholes, then it can be pulled through from both ends so that about 1.5 metres of cable overlap. The cable is then spliced together using the G.T.E. splice connectors. If it is impossible to pull the cable through, as with buried cable, then fibres will have to be "pieced in" or, if the damage is extensive, interruption cable layed.

In some situations where a number of fibres are still functional, it may be desirable to leave as much of the cable intact as possible. In this case the cable is not cut; instead, it is stripped of about 460mm of outer sheath both sides of the damaged area.
The damaged area is bridged across by cutting the damaged fibres near the cable sheath closest to the fault location and splicing in the required number of fibres from an interuption cable. There would normally be no need in this situation to join the copper conductors, if present, or to join the central tension member, as they would be left intact. Suitable communication with the exchange must, however still be established.
Refer Page I-13.



FIBRES LEFT INTACT

Cable And Sheath Preparation (Cont'd)

For both the above situations, lay down the ground-sheet at the joint location, to provide a clean working environment. Clean and prepare the stripped cable sections (Refer Linemens Handbook OFC Installation Section I). Take care not to damage the fibres during sheath removal. Remove cable wrapping and "dummy" cable fillers where applicable. Identify and tag all fibres with their respective numbers. Also identify and label both exchange and country sides of the cable.

For completely severed cable, prepare and join cable tension members so that the sheath to sheath opening is 460mm. The central tension member may be left unjointed if desired. It must, however still be prepared for jointing to avoid unnecessary disturbance of the joint during cut-over procedures. If the cable has a moisture barrier sheath, then the continuity wire should be connected at this stage.

For Optical Fibre Cables with fibre coatings of 0.50mm or less, break-out protection tubes should be fitted. Refer Linemens Handbook, Optical Fibre Cable Installation, Section I. They are not required for fibres with 0.90mm coatings. Although it is recommended that the protection tubes be fitted, if time is critical 15 minutes to 1 hour may be saved (depending upon cable size) by not fitting them. In that case, extreme care must be exercised to avoid damaging the unprotected fibres during handling. Cut-over procedures will also be more difficult if the protection tubes are not fitted as complete fibre units (up to 10 fibres per unit) will have to be cut to fit the tubes during cut-over.

Fit end caps and closure tie bars to the cable ends as described in Section K of Linemens Handbook Optical Fibre Cable Installation or Siemens installation instructions. For situations where the cable has been left intact, one end will be a multiple lead-in to accommodate the interruption cable.

Jointing Copper Conductors

If copper conductors are present, they should be jointed using water resistant connectors. Select one pair for a three wire joint, and connect an additional 0.64mm pair for use as a communication pair between the maintenance team and the exchange. Communication should be established with the exchange at this point. The joined conductors should be placed alongside the tension member and tied into position, using linen tape.

Generally, single mode cable will be non-metallic, so a means of communication between the maintenance team and the exchange must be established. This may be achieved by two way radio communication, or via a landline.

Splicing and Housing of Fibres

Select the first fibre to be spliced. For cable that has not been completely cut, the selected fibre to be spliced is cut near the cable sheath closest to the cable fault.

Thoroughly clean 60mm of unstripped fibre with cleaning pads and eucalyptus oil.

Holding the fibre with the rubber coated hinge, strip the outer jacket from the fibre and cleave the fibre so that 6mm to 9mm of bare fibre protrudes from the nylon jacket.

The fibre is carefully inserted into the glass splice tube about to the mid-way position.
Repeat above steps for the second fibre.

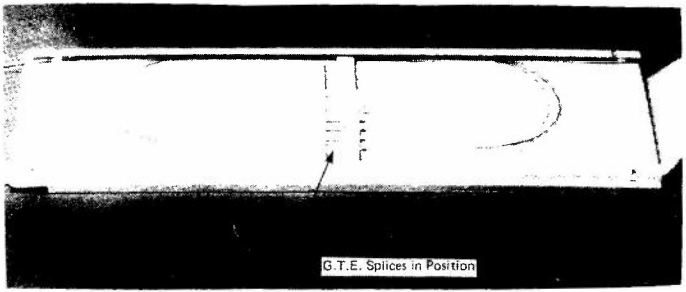
Splicing And Housing Of Fibre (Cont'd)

Repeat above steps for the second fibre.

Insert the second fibre into the opposite end of the glass splice tube until it can be felt butting up against the first fibre. Gently move the fibre backwards and forwards a few times to remove any air bubbles.

If desired, apply a bead of sealing compound or super glue to either end of the splice to seal and hold the fibres in position. (Note: If the fibres are sealed in position, then the GTE connector will have to be discarded after use.)

Repeat the above procedures to splice together all the fibres.



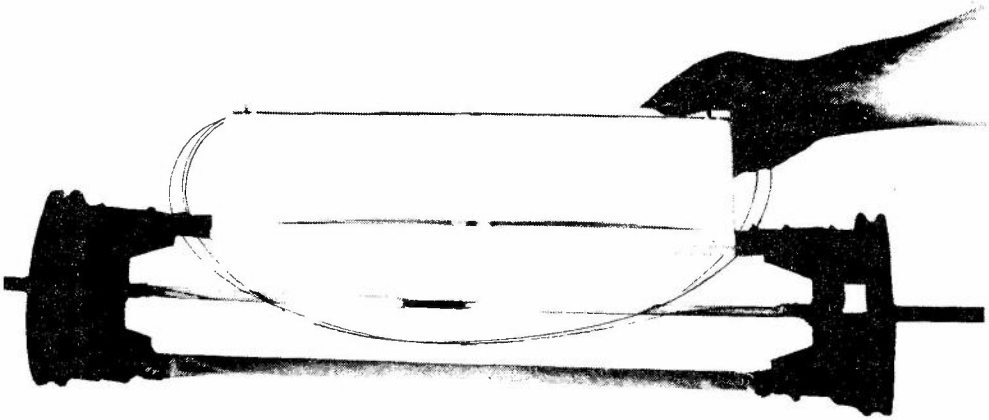
G.T.E. SPLICES IN NORTHERN TELECOM ORGANIZER

Splicing And Housing Of Fibre (Cont'd)

As each fibre is completed, place it in position on the double sided tape previously applied to the organiser tray. Slack fibre or break-out protection tubes should be looped in the usual way. If needed, tape the fibres or tubes together using linen tape, to help maintain a tidy bundle. P.V.C. tape should not be used to tape the fibres together as this may damage the fibres

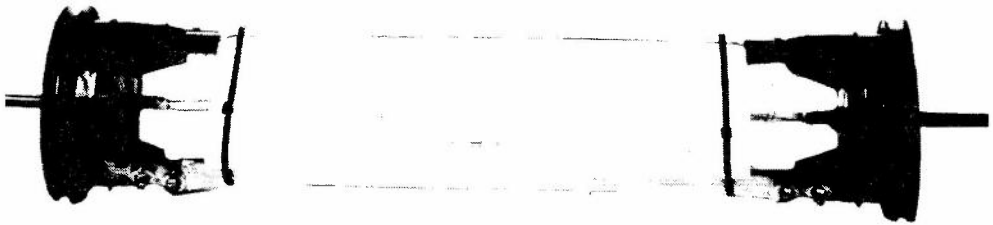
Fit the inner wrap and outer sleeve to the joint closure and seal as per Section K in Linemens Handbook, Optical Fibre Cable Installation or Siemens instructions. Take care not to damage the fibres during this procedure.

If a second joint is required, as with interruption cable, then repeat the above procedures for the second repair joint of the repair cable. This may be done simultaneously by a second jointer, in which case adequate communication must also be established between the two jointing locations. As each fibre is completed, communicate to the exchange that traffic may be resumed on that fibre. Successful transmission indicates that the repair splice is adequate. If unsuccessful redo the splice.



FIBRES LOOPED BEFORE FITTING ORGANIZER TO CLOSURE

After the repair joint has been completed, it should be placed where there is the least likelihood of disturbance and/or damage. If necessary, install temporary barricades to prevent accidental damage to the joint.



G.T.E. SPLICES AND FIBRES FITTED INTO NORTHERN TELECOM ORGANIZER

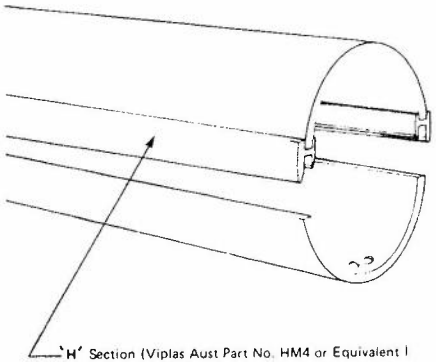
When the permanent fusion splicing is performed, the Siemens closure used for the temporary repair may be re-used for the permanent splice closure.

METHOD TWO - REPAIR PROCEDURES USING SPLIT CONDUIT

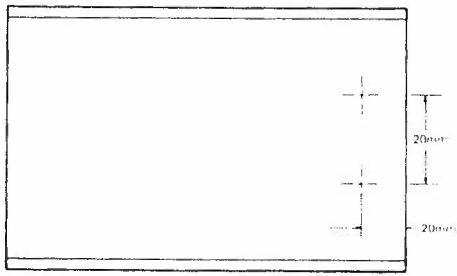
It is quicker to install than method 1.
This method uses materials readily available in stores and so allows damaged cable to be repaired when a Siemens closure and tool kit are not immediately available.

Materials and Tools Required

The tools and materials listed on Page I-8, I-9 and I-10 are also required for method two, with the exception of the Siemens closure, Siemens tool kit, and Northern Telecom Organizer trays. The following will also be required :
Break-out protection tubes (610mm length) from Northern Telecom organizer kits.
100mm conduit (S73/207) 800mm long. For easier application this conduit should be split longitudinally to produce two halves. The halves can then be rejoined after splicing, using "H" section (Viplas Aust. Part No. HM4 or equivalent).



SPLIT CONDUIT



HOLE LOCATION

Materials And Tools Required (Cont'd)

The lower conduit section should have two 6mm holes drilled into each end, about 20mm from each end. (To locate cable ties). A length of double sided tape should be placed in the centre of the conduit to assist in the positioning of the G.T.E. splices.

Two heavy duty plastic bags, (about 160mm x 160mm) large enough to fit the ends of the conduits. These are used to seal the ends of the split conduit after completion of the joint.

Two cable ties 110mm long x 4.8mm wide (Panduit PLT3S or equivalent). These are for locating the cable ends to the split conduit.

Cable and Sheath Preparation

Cable preparation for this method will be similar to that for method 1, described on Pages I-11. The preparation may again be approached in one of two ways.

After location of the fault, if the damage is extensive then the damaged cable is removed. If possible the cable ends are pulled through and the ends prepared for splicing. If it is impossible to pull the cable through, then fibres will have to be pieced-in or interruption cable layed.

For situations where some fibres are still functional and it is desired to leave as much of the cable intact as possible, then the outer sheath only is stripped off to expose the damaged fibres in preparation for splicing.

Sheath And Cable Preparation (Cont'd)

For both situations, lay down the ground-sheet to provide a clean working environment. After the cable has been cleaned and before stripping the outer sheath, fit the plastic bags to either side of the joint location. That is achieved either by making a hole in the ends of the bags and sliding over the cable ends, or, if the cable has been left intact, by slitting the bags and retaping them over the cable, using P.V.C. tape. The cable is then stripped and cleaned in preparation for the splicing operation. The central tension member may be left unjointed, as the cable ties, (described below), will be enough to locate the cable with the desired sheath opening against the split conduit. The central tension member must, however, still be prepared for jointing to assist in cut-over operations.

For Optical Fibre Cables with fibre coatings of 0.50mm or less, the break-out protection tubes should be fitted. Refer Section J.

After stripping and cleaning the cable, place the drilled half of the PVC conduit under the area of the joint. Tie the cable to the conduit using the cable ties so that a sheath opening of 460mm is maintained. If the cable is left intact, then an interruption cable will also be fastened to one end of the PVC conduit using the cable ties.

Jointing Copper Conductors

If necessary, the copper conductors are joined as described and communications established as described on Page I-13.

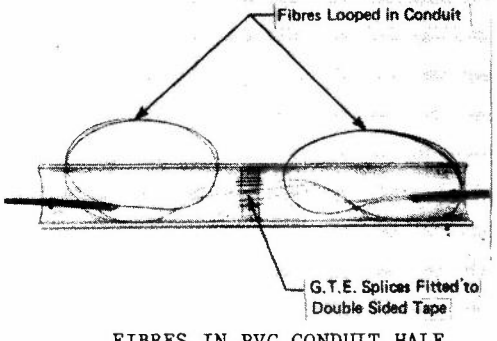
Splicing and Housing of Fibres

Select the first fibres to be spliced.

Splice the fibres together using the G.T.E. splices.

Place the splice inside the conduit, half-positioned on the double sided tape, and proceed to the next fibre. The fibre should be formed into a loop at each end of the splice housing (See below) and taped to any fibres already in position. That is important to prevent fibres from tangling.

Repeat the above procedures to splice together all the fibres to effect a satisfactory repair to the cable. With linen tape, loosely tape together the fibre loops to form neat bundles. Ensure that the radius of the fibres is greater than 50mm.

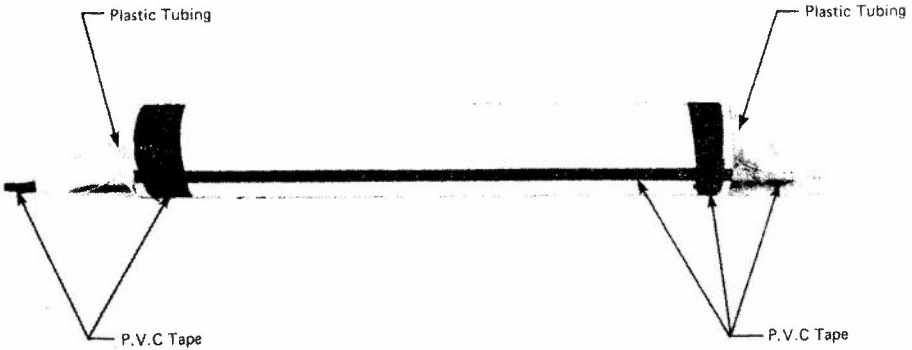


FIBRES IN PVC CONDUIT HALF

Splicing And Housing Of Fibres (Cont'd)

After all necessary fibres and conductors have been spliced and placed in the lower half of the PVC Conduit, the upper half of the conduit may be fitted into position and the conduit taped together using PVC tape. Run a length of PVC tape along the seams to achieve a seal.

Wrap the ends of the conduit and cable with the plastic bags, ensuring the 6 mm holes and cable ties are adequately covered. Seal with PVC tape. See below.



COMPLETED REPAIR SPLICE

SECOND JOINT

If a second joint is required repeat the above procedures for the second repair joint.

As each fibre is completed, communicate with the exchange as described on Page I-13.

ACCEPTANCE TESTING OF COMPLETED SPLICES

As these splices are a temporary repair, required to be in service for only a short time formal testing by Transmission Measurement staff will not be required. For these temporary splices only, it will be considered that a suitable splice has been achieved if normal transmission can be resumed. If not successful repeat G.T.E. splice operation.

REFERENCES

TPH 1619 EP Emergency Repair Splicing of Singlemode and Multimode Optical Fibre Cable.

SECTION J

FIELD FITTING HAULING EYES

- SAFETY REQUIREMENTS
- INSTALLING HEARTHILL TYPE HAULING EYE
- INSTALLING SUMITOMO TYPE HAULING EYE
- POST HAULING TESTING/ACTION

Issue 1, 1987

FIELD FITTING HAULING EYES

GENERAL

It may be necessary to fit hauling eyes in the field to optical fibre cables to enable faulty lengths to be withdrawn from a subduct or conduit and allow a new cable length to be installed. Two types of hauling eyes are available, Hearthill and Sumitomo.

SAFETY REQUIREMENTS

Wear suitable leather gloves to avoid cuts from knives and the central wire tension member.

Safety goggles must be worn when using the crimping tool.

Operators must ensure that the guard around the small stranded crimping wire is securely in place prior to crimping and that the maximum pressures specified for particular cables to be crimped are not exceeded.

Operators should examine the small stranded crimping wire periodically looking for frays or breaks in the metal strands. Worn wire should be scrapped and replaced.

Hydraulic power circuits must be equipped with pressure relief valves set at 2 MPa.

Hydraulic fittings and connections must be periodically checked to reduce the chance of an accidental disconnection.

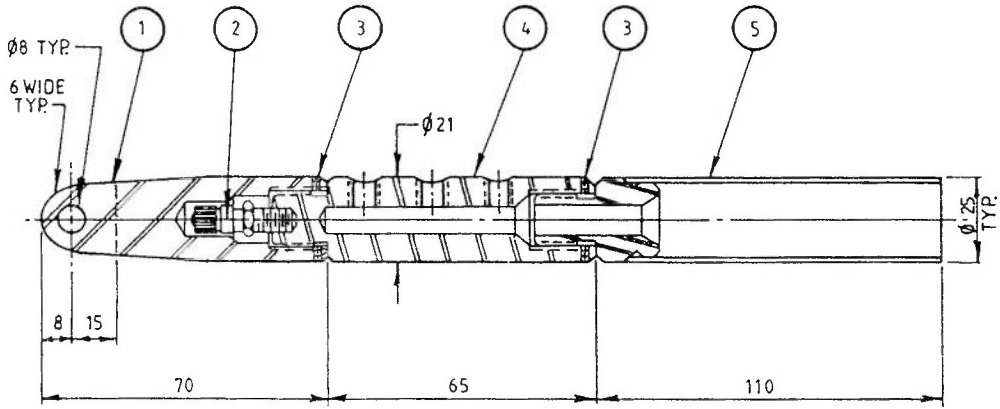
The operator must ensure that his hands are clear of the stranded wire crimping cable and crimping die both during the crimping operation and upon release of the pressure.

Issue 1, 1987

Hearthill Catalogue No.	Diameter (mm)	
	A	B
89250 - 03	10.9	5.9
89250 - 04	12.5	5.9
89250 - 05	14.0	5.9
89250 - 06	15.5	5.9
89250 - 07	17.0	5.9
89250 - 08	20.0	5.9
89250 - 09	23.5	5.9
89260 - 03	10.9	5.9
89260 - 04	12.5	5.9
89260 - 05	14.0	5.9
89260 - 06	15.5	5.9
89260 - 07	17.0	5.9
89260 - 08	20.0	5.9
89260 - 09	23.5	5.9
89261 - 08	20.0	5.5
89262 - 08	20.0	5.0
89263 - 08	20.0	5.0
89264 - 07	19.0	3.9
89264 - 08	20.0	3.9
89264 - 09	23.5	3.9
89264 - 10	24.0	3.9
89280 - 03	8.7	3.5
89280 - 05	12.5	4.2
89250 - 06	15.5	5.9

HEARTHILL PRESSURISABLE TYPE HAULING EYES

FIELD FITTING HAULING EYES



NOTE: TYPICAL DIMENSIONS SHOWN

1. SCREW ON CAP
2. SCHRADER VALVE
3. LOCKING SET SCREWS
4. CENTRAL MEMBER BODY
5. CABLE SHEATH COVER

HEARTHILL TYPE HAULING EYE

INSTALLING HEARTHILL TYPE HAULING EYES

Measure the outside diameter of the optical fibre cable to be used. Select a cable hauling eye with a sleeve clearance between 1 and 3 mm over the cable diameter. See Page J-3 for types available and Page J-4 for a sectioned view.

Ensure the following tools are on hand:

Optic Fibre Crimping Kit, complete with dies and stranded crimping wires.

Hand pump-up hydraulic, portable power-pack unit.

Thread locking compound for set screws - loctite or similar.

Hexagon socket wrenches.

Schrader valve, if necessary.

Slotted head, medium screwdriver.

Hauling Eye Preparation

Remove the three locking set screws from the body of the hauling eye.

Seal thread with loctite compound, then screw into the body the appropriate cable sheath shroud and securely tighten the two locking set screws.

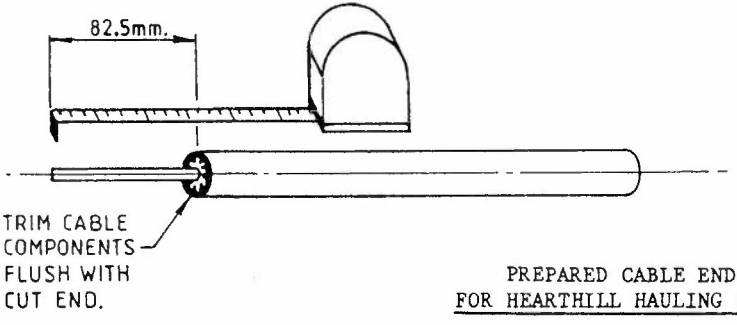
Tighten the hauling eye head onto the main body and securely tighten the two locking screws.

Cable Preparation

Remove the outer cable sheath for a length of 82.5 mm and carefully cut away all cable components (See illustration below) to expose a bare central tension member.

Insert the cable into the cables shroud and push it home until the central tension member is visible under the three locking screw holes, in the central body of the hauling head.

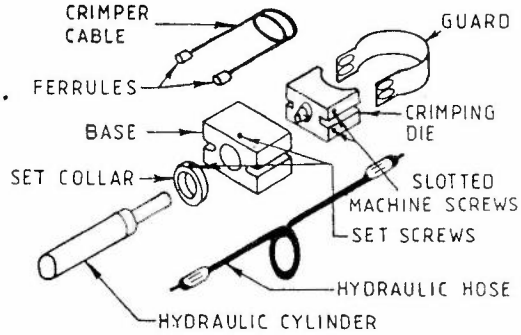
Apply loctite screw locking compound to the three set screws, install and tighten the screw closest to the cable, followed by the central screw and the third screw. Tighten all screws to a torque of 25 Nm.



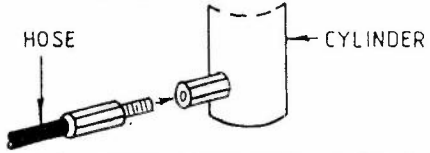
PREPARED CABLE END FOR HEARTHILL HAULING EYE

Crimping the Cable Sheath Cover - Hydraulic Crimper Components

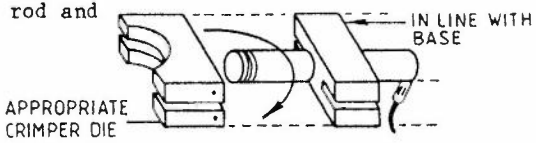
Prepare Fibre Optic Crimper Assembly. The assembly consists of a hydraulic cylinder base, set collar, crimper cable, guard, hydraulic hose and crimper die, if required.



Connect the hydraulic cylinder to the hydraulic pump unit.



Screw the appropriate crimper die onto the cylinder rod until the end of the crimper die is tight against the end of the rod and properly in line with the base.

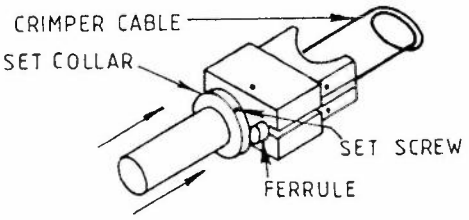


Crimping the Cable Sheath Cover- Hydraulic Crimper Components (Cont'd)

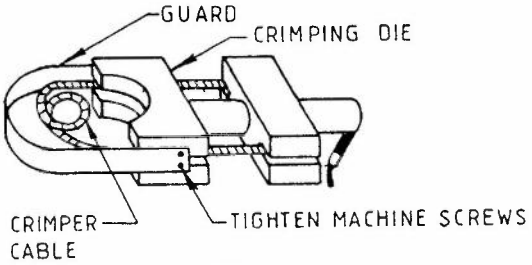
Make a loop with the selected crimper cable and slip the crimper cable into the slot on each side of the crimper die and base. Slip the ferrule at each end of the crimper cable into the retainer hole in the bottom of the base. Slide the collar up the cylinder until flush against the ferrules forcing them home. Secure the collar in place by tightening the set screw. The collar ensures that the ferrules cannot drop out of the retainer base. (See A below).

Slip the guard over the crimper cable. Secure the crimper die by inserting the slotted holes in the guard around the machine screws on the crimper die. Tighten the machine screws. The crimper is ready for operation. (See B below).

If the crimper is equipped with an inappropriate crimper die and crimper cable, these must be removed as follows:



(A)



(B)

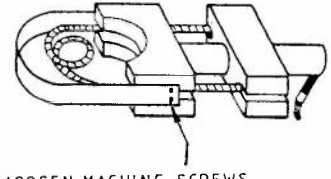
Crimping the Cable Sheath Cover- Hydraulic Crimper Components (Cont'd)

Remove the guard by loosening the machine screws (see C below) which secure the guard to the crimper die. Slide the guard downward and off the crimper die.

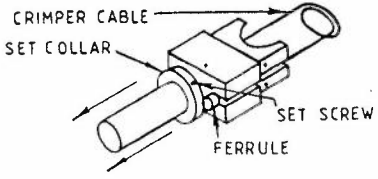
Remove the crimper cable which is on the crimper by loosening the set screw on the collar and dropping the collar down. This action frees the ferrules and the crimper cable can be removed easily. (See D below).

To remove the crimper die, (see E below), fully extend the cylinder rod and maintain pressure using the hydraulic pump. Unscrew the crimper die from the cylinder rod.

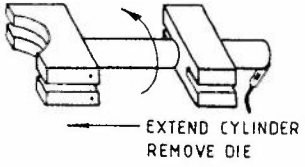
The longitudinal head requires three crimps on the cables shroud. At each location three separate crimps are made at 120° with respect to each other. See page J-10.



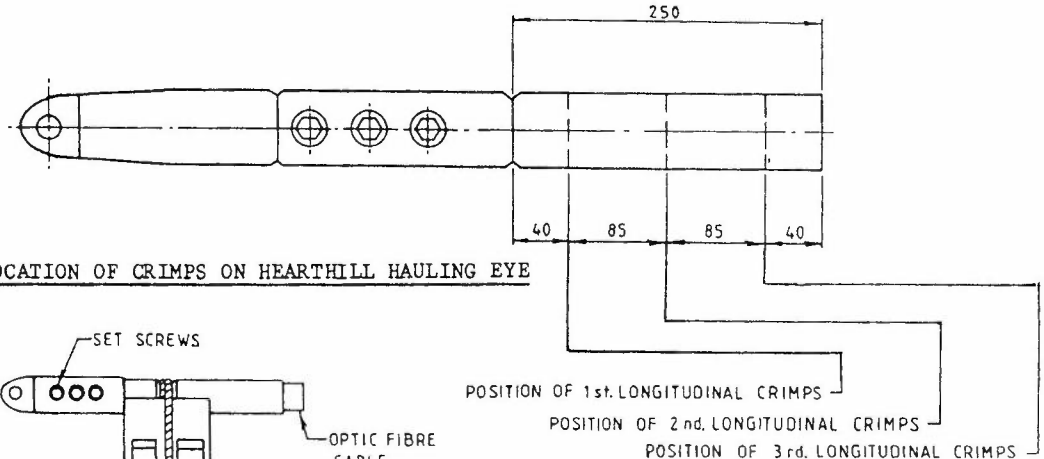
(C)



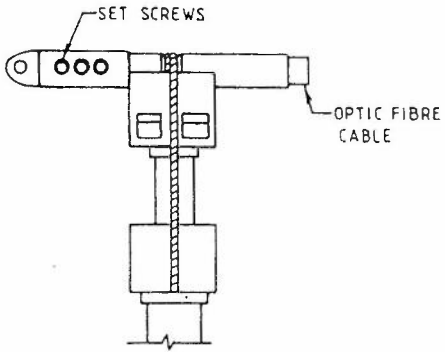
(D)



(E)



LOCATION OF CRIMPS ON HEARTHILL HAULING EYE

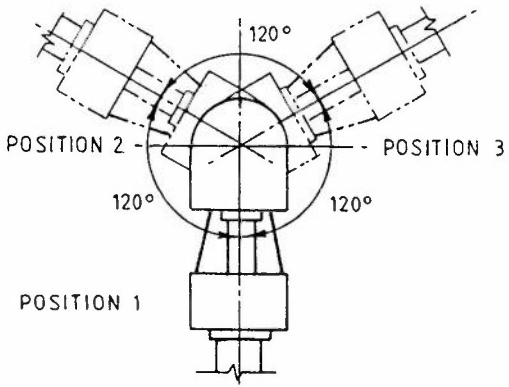


FIRST LONGITUDINAL CRIMP POSITION ON HEARTHILL HAULING EYE

Crimping the Cable Sheath Cover- Hydraulic Crimper Components (Cont'd)

Slide the loop of crimper cable onto the hauling head, to the position of the first crimp. Do not cross the loop. See Page J-10.

Apply hydraulic pressure via the hydraulic pump until a deep crimp is obtained, and the pressure relief valve operates. Make the second crimp 120° away from the first, and the third crimp 120° away from the second. Always rotate the crimping tool in the same direction of rotation. See below and Page J-12.

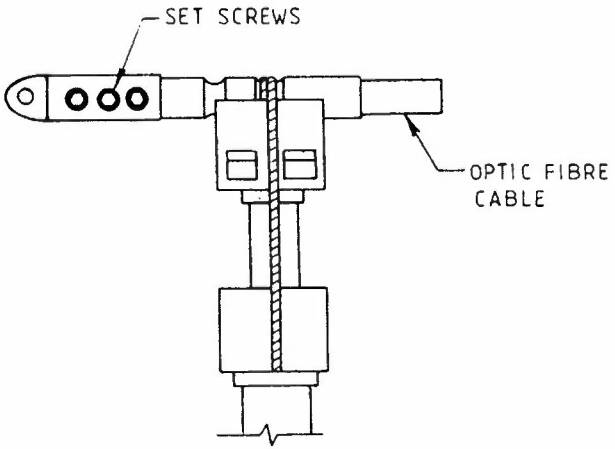


CRIMP SPACINGS, AT EACH LONGITUDINAL CRIMPING POSITION

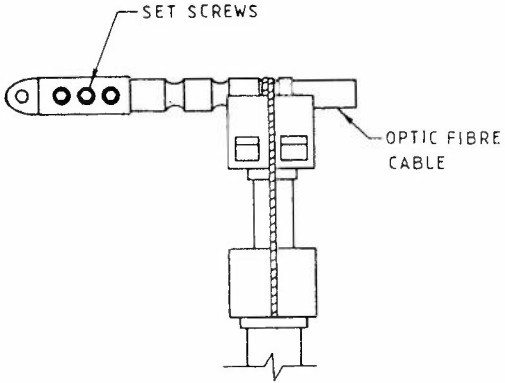
Crimping the Cable Sheath Cover- Hydraulic Crimper Components (Cont'd)

To start the second longitudinal crimp, position the edge of the crimper die at the centre of the first longitudinal crimp position and make the first crimp, followed by the second and third crimp, at a 120° spacing between.

Make the third longitudinal crimp, with the edge of the crimping die at the second longitudinal crimping position. See Page J-13.



SECOND LONGITUDINAL CRIMP POSITION



THIRD LONGITUDINAL CRIMP POSITION

Fitting Thermoshrink Tube

Select a suitable thermoshrink tube e.g. Raychem MWTM 37/12 x 250 mm long with hot melt adhesive. (HMA)

Using emery paper, abrade the cables sheath adjacent to the end of the hauling eye for 200 mm.

Using a hot air gun or soft flame burner, heat treat the cables sheath.

FIELD FITTING HAULING EYES

Fitting Thermoshrink Tube

Slide the length of thermoshrink tube over the hauling eye until the end is at the location of the hauling eye joint. The tube should cover the three tightened set screws, between the hauling head and main body.

Using a soft flame burner or hot air gun in small oscillating motions, heat the end of the thermoshrink tube until it has shrunk onto the hauling eye. Allow it to cool. Shrink the remainder of the tube, to produce a smooth wrinkle free finish, until adhesive exudes from each end and allow to cool.

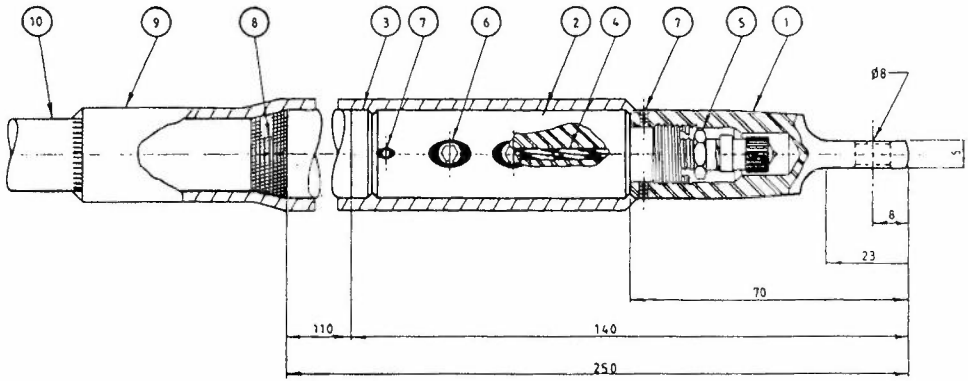
Pressurising the Cable

Remove the hauling eye head from the hauling eye, uncap the schrader valve.

Connect a cylinder of dry air to the cable, with a hose and pressure gauge. Test air feeding assembly for leaks.

Feed air into the cable at 100 kPa, until the cable holds 70 kPa steady air pressure.

Replace hauling eye head, and tighten two locking screws. The cable is now ready for hauling.



1. SCREW ON CAP
2. CENTRAL MEMBER BODY
3. CABLE SHEATH COVER
4. CENTRAL MEMBER TUBE
5. 1/8 NPT SCHRADER VALVE
6. 5/16-24 SET SCREW (HEX HEAD)
7. #8-32 x 1/8 LG LOCKING SET SCREWS
8. BUTYL PUTTY
9. THERMO-SHRINK TUBE WITH (HMA) HOT MELT ADHESIVE
10. OPTICAL FIBRE CABLE

COMPLETED HEARTHILL HAULING EYE

Issue 1, 1987

FIELD FITTING HAULING EYES

Sumitomo Type

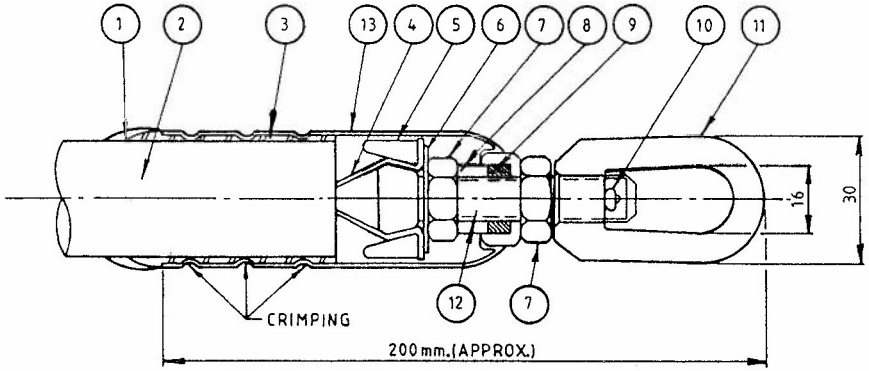
This hauling eye can be fitted to a Sumitomo optical fibre cable that has a stranded wire central tension member e.g. 7/1.0, 7/1.2, 7/1.4, 7/1.6, 7/1.8 mm.
(7 strands of wire and diameter of).
The tools and materials needed are listed below.

Material Description	Qty
Hauling Eye	Set
Butyl Putty	Roll
Tape, PVC	Roll

MATERIAL

Description of Tools	Qty	Remarks
High Tensile Wire Cutter	1	Used for cutting cable and C.T.M.
Knife Sheath stripper	1	Stripping Sheath
Pliers	1	
Diagonal Side Cutters	1	
Hammer	1	
Adjustable Spanner	1	
Wire Crimping Tool	1	

Tools



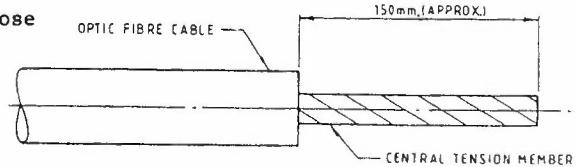
1. P.V.C. TAPE.
2. OPTICAL FIBRE CABLE.
3. BUTYL PUTTY.
4. TENSION MEMBER.
5. CLAMPING RING.
6. WASHER.
7. LOCK NUT.
8. SPACER.
9. RUBBER WASHER.
10. SPLIT PIN.
11. EYENUT.
12. CENTRAL SPINDLE.
13. CABLE SHEATH SLEEVE.

SUMITOMO TYPE HAULING EYE

FIELD FITTING HAULING EYES

Preparing Cable End

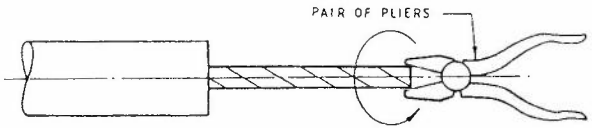
Cut cable sheath and components to expose the central tension member for 150 mm.



Prepared Cable End
for Sumitomo Hauling Eye

Remove polyethylene sheath from central tension member. Using pliers, carefully untwist the wire. Avoid cutting the skin.

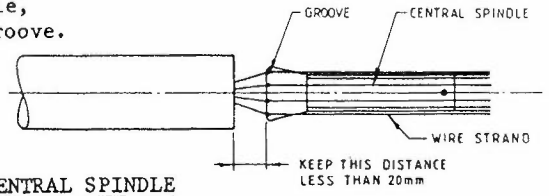
Straighten each wire



UNTWISTING WIRE CTM

Fitting Hauling Eye to CTM

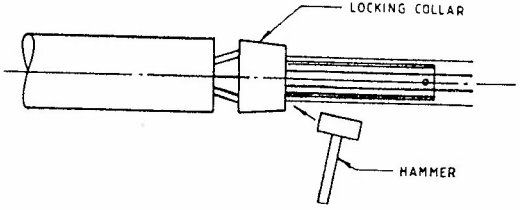
Locate each straightened wire longitudinally along the central spindle, with each wire located in a separate groove.



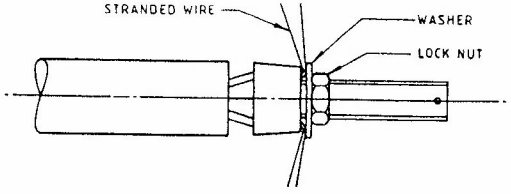
FITTING CENTRAL SPINDLE

Place the clamping collar over all wires and tap with a hammer until it is firmly clamping the wires onto the central spindle.

Fit and tighten the locknut to a torque of 23 to 25 Nm.

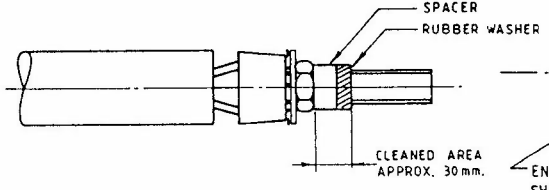


FITTING CLAMPING COLLAR

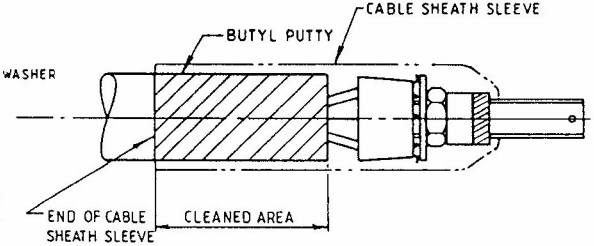


TIGHTENING LOCKNUT

Trim wire strands around the locking collar. Avoid cutting the skin.
Clean spacer and rubber washer, then place spacer and rubber washer onto the central spindle.



TRIMMING WIRE STRANDS



PLACING SPACER AND RUBBER WASHER

Cable Sheath Preparation

Clean cable sheath with cotton waste for 200 mm.
Apply a small amount of butyl putty to the sheath until the diameter is just slightly less than the inner diameter of the cables sheath cover.

Crimping the Cables Sheath Cover

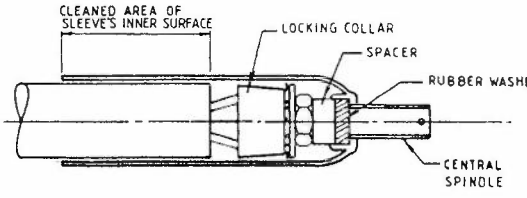
Clean the inside of the cables sheath cover.
Slip the cables sheath cover onto the central spindle and over the butyl putty.
Fit and tighten the locknut to a torque of 10 Nm.
Crimp the cable sheath cover as illustrated on Page J-21.
Dress end of cable sheath cover down onto the cables sheath.
Select a suitable thermoshrink tube e.g. Raychem MWTM 37/12 x 200 mm long, with hot melt adhesive and shrink it.
Screw on the hauling eye, fit and fasten the split pin which prevents the hauling eye coming off during cable installation.

POST HAULING TESTING/ACTION

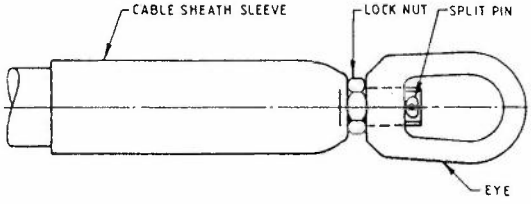
For a Hearthill type hauling eye, the cable pressure should be checked after installation. The cable pressure should be steady at 70 kPa. If a leak is evident it must be found and fixed.

Hauling eyes can be left on the cable that is taped and coiled in the manhole for subsequent jointing.

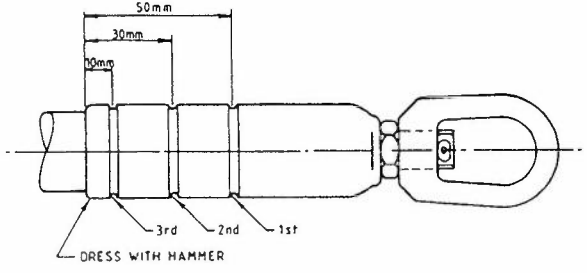
Collect hauling eyes, complete or in part, for later or emergency use to recover faulty optical fibre cable. It is good practice to assemble and keep these eyes at the depot store for later use, if required.



PART ASSEMBLED SUMITONO HAULING EYE



ASSEMBLED SUMITOMO HAULING EYE



CRIMPING POSITIONS FOR SUMITOMO HAULING EYE

SECTION K

REMOTE AREA REPEATER MAINTENANCE REQUIREMENTS

- INSPECTION
- REPEATER MAINTENANCE
- EARTH SYSTEM INSPECTION

Issue 1, 1987

Inspection

After one calendar year from the initial installation, all repeater shelters must be inspected for foundation subsidence. Any settlement must be made good. The aboveground equipment shelter can be re-levelled using the levelling bolts if necessary.

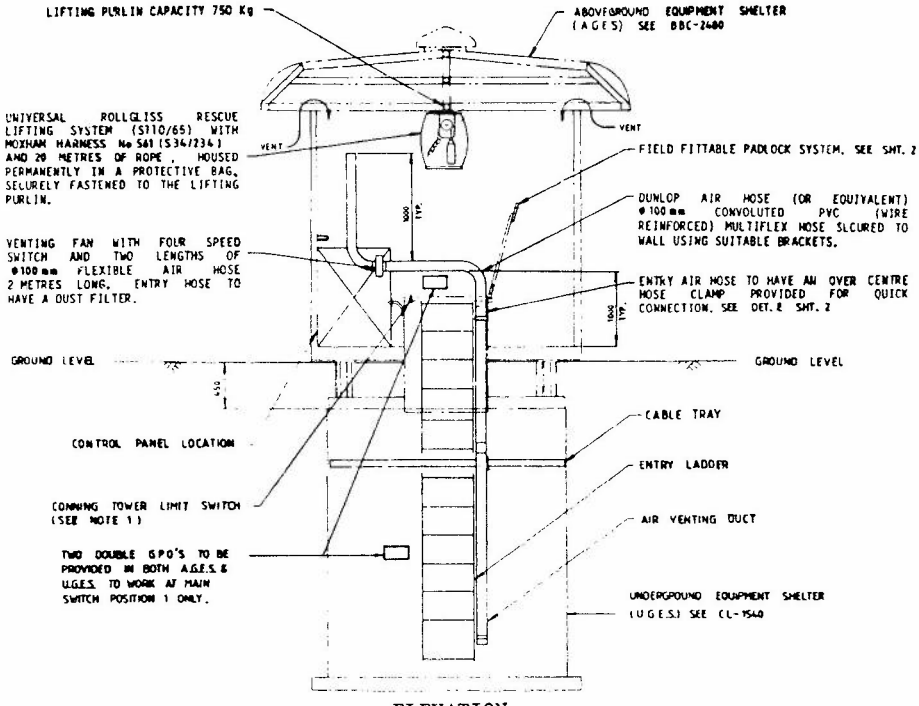
If ever a pole has to be adjusted for vertical alignment, carefully break away the weak grout, align and level pole, tighten nuts, and reinstall more weak grout.

Voltage measurement of the polarisation probe, earth system resistance measurement and cathodic protection system inspection shall be carried out periodically, e.g. every few years.

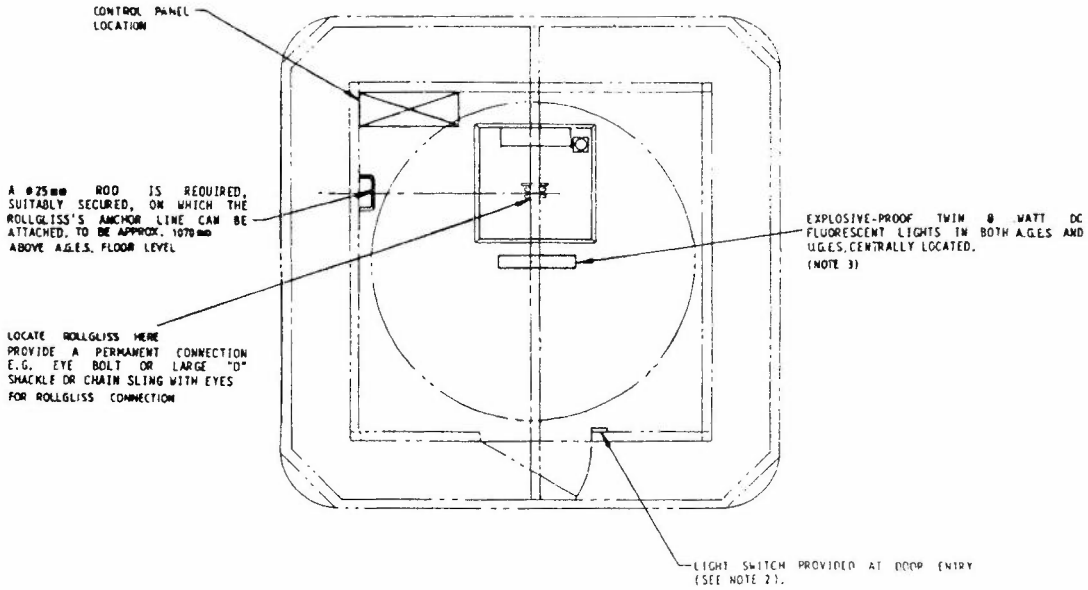
As the cathodic protection system's sacrifical zinc anodes will corrode away over a period of years, the anodes located at the four side positions along with the two anodes located above the underground equipment shelter may need to be renewed.

Renewal can be achieved fairly easily, whereas the two anodes located under the shelter may be considered too difficult to replace, unless it is absolutely necessary to do so.

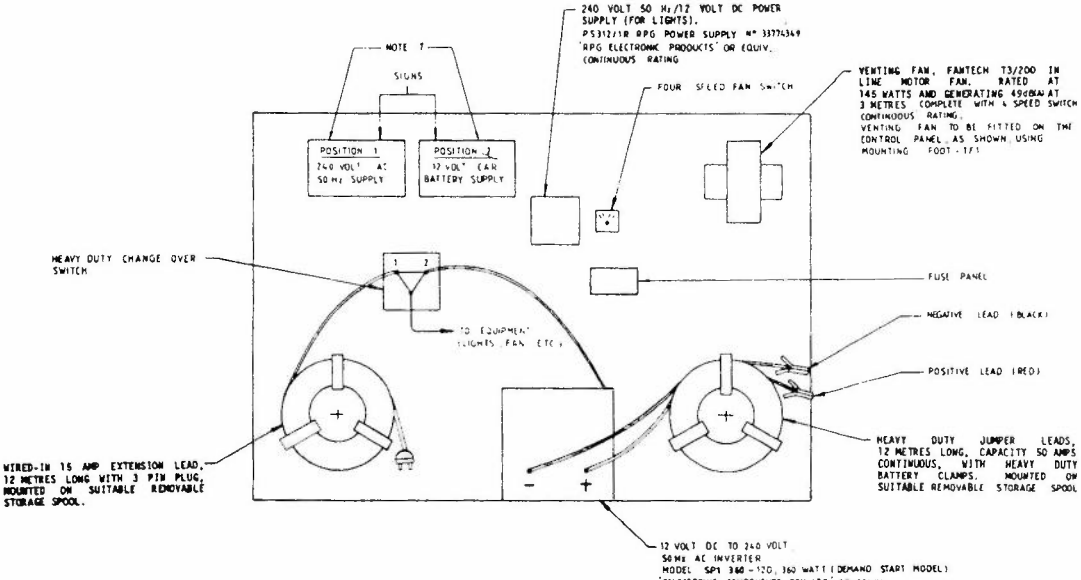
Similarly, if after its useful life of some 20 years the polarisation probe PP3 needs replacing, it can be replaced as described in TPH 1553 EP.


LIFTING PURLIN CAPACITY 750 Kg
ABOVEGROUND EQUIPMENT SHELTER (AGES) SEE BBC-2480
UNIVERSAL ROLLGLISS RESCUE LIFTING SYSTEM (ST10/65) WITH MOIRAM HARNESS No 561 (S34/234) AND 20 METRES OF ROPE, HOUSED PERMANENTLY IN A PROTECTIVE BAG, SECURELY FASTENED TO THE LIFTING PURLIN.
VENT
VENT
FIELD FITTABLE PADLOCK SYSTEM. SEE SHT. 2
DUNLOP AIR HOSE (OR EQUIVALENT) ø100 mm CONVOLUTED PVC (WIRE REINFORCED) MULTIFLEX HOSE SECURED TO WALL USING SUITABLE BRACKETS.
VENTING FAN WITH FOUR SPEED SWITCH AND TWO LENGTHS OF ø100 mm FLEXIBLE AIR HOSE 2 METRES LONG. ENTRY HOSE TO HAVE A DUST FILTER.
1000 TYP.
ENTRY AIR HOSE TO HAVE AN OVER CENTRE HOSE CLAMP PROVIDED FOR QUICK CONNECTION. SEE DET. 2 SHT. 2
1000 TYP.
GROUND LEVEL
GROUND LEVEL
450
CABLE TRAY
CONTROL PANEL LOCATION
ENTRY LADDER
CONNING TOWER LIMIT SWITCH (SEE NOTE 1)
AIR VENTING DUCT
TWO DOUBLE GPO'S TO BE PROVIDED IN BOTH A.G.E.S. & U.G.E.S. TO WORK AT MAIN SWITCH POSITION 1 ONLY.
UNDERGROUND EQUIPMENT SHELTER (U.G.E.S.) SEE CL-1540

ELEVATION


CONTROL PANEL LOCATION
A ø25mm ROD IS REQUIRED, SUITABLY SECURED, ON WHICH THE ROLLGLISS'S ANCHOR LINE CAN BE ATTACHED. TO BE APPROX. 1070mm ABOVE A.G.E.S. FLOOR LEVEL
LOCATE ROLLGLISS HERE PROVIDE A PERMANENT CONNECTION E.G. EYE BOLT OR LARGE "D" SHACKLE OR CHAIN SLING WITH EYES FOR ROLLGLISS CONNECTION
EXPLOSIVE-PROOF TWIN 8 WATT DC FLUORESCENT LIGHTS IN BOTH A.G.E.S AND U.G.E.S, CENTRALLY LOCATED. (NOTE 3)
LIGHT SWITCH PROVIDED AT DOOR ENTRY (SEE NOTE 2).

PLAN



SCHEMATIC LAYOUT OF CONTROL PANEL

REMOTE AREA REPEATER - MAINTENANCE REQUIREMENTS

NOTES:

1. EXPLOSIVE-PROOF CONNING TOWER COVER OPERATER LIMIT SWITCH CONNECTED TO THE NEAREST MANNED EXCHANGE TO RAISE AN ALARM IF THE COVER IS OPENED.

2. EXPLOSIVE-PROOF ENTRY DOOR-OPERATED LIMIT SWITCH CONNECTED TO THE NEAREST MANNED EXCHANGE TO RAISE AN ALARM IF ENTRY DOOR IS OPENED. SIMILAR TO THAT IN U.G.E.S.

3. DC FLOURESCENT LIGHTS TWIN 8 WATT, EXPLOSIVE-PROOF TYPES.

4. AT REMOTE SOLAR SITES FOR EMERGENCY NIGHT VISITS, VEHICLE HEAD LIGHTS CAN BE USED TO LIGHT UP THE SITE THEREBY ENABLING EASY, QUICK CONNECTION OF THE VEHICLE'S BATTERY TO THE REPEATER'S INTERNAL LIGHTS. THIS ACTIVITY SHOULD TAKE A MINIMUM TIME.

   ALTERNATIVELY, IF THE LOCAL OPERATIONS DISTRICT CAN GUARANTEE, E.G. BY STANDING ORDERS, THAT EVERY VISITOR TO A REMOTE REPEATER SITE WILL TAKE A PORTABLE 240 VOLT GENERATOR (OF ADEQUATE POWER RATING), THEN THE RECOMMENDED LOW POWER DC FLOURESCENT LIGHTS MAY BE REPLACED BY AN EXPLOSIVE-PROOF DUAL 240 VOLT 50 Hz 20 WATT FLOURESCENT LIGHT UNIT.

5. ALL LIFTING GEAR TO BE DLI APPROVED OR DESIGNED, AND INSTALLED TO THEIR REQUIREMENTS.

6. ROLLGLISS TO BE CHECKED (ESPECIALLY THE ROPE) ANNUALLY.

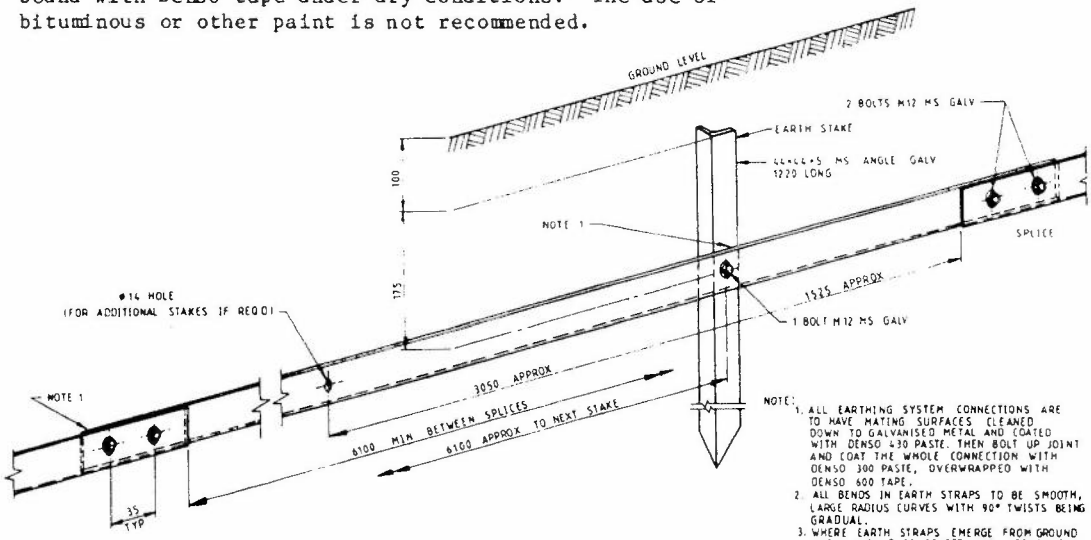
7. (a) POSITION 1 PORTABLE GENERATOR SUPPLY. INTENDED FOR A MAJOR MAINTENANCE VISIT OF SAY $^1/_2$ DAYS DURATION

   (b) POSITION 2 VEHICLE BATTERY SUPPLY. INTENDED FOR A MINOR MAINTENANCE VISIT OF SAY 30 MINS. DURATION.

NOTES

Earth System Inspection

All bonding straps and links should have samples inspected at 5 yearly intervals, and then replaced if showing damage through corrosion. Any failed Denso bonds should be recoated with suitable Denso paste and securely bound with Denso tape under dry conditions. The use of bituminous or other paint is not recommended.



EARTH SYSTEM

No.	Description of Item	Qty
1.	Radial Conductor: 50 mm X 3 mm galvanised mild steel strap 60 metres in length (made up by 6 metre bolted lengths). (Note 1).	3
2.	Earth Stakes: "L" section galvanised mild steel 44mm X 44mm X 5mm, 1.2 metres long. (Note 1).	30-50
3.	Underground Equipment Shelter Conductor: 50 mm X 3 mm galvanised m.s. strap 17 metres long (Notes 1 and 2).	1
4.	Solar Array/Pole Earth Conductor: 50 mm X 3 mm galvanised m.s. strap 7 metres long (Notes 1 and 2).	1
5.	Interconnecting Conductor: 50 mm X 3 mm galvanised m.s. strap 5 to 10 metres long as required (Notes 1 and 3).	1
6.	Bolts, nuts and washers: 12 mm diameter X 30 mm long, hot dipped galvanised. (Note 4)	120
	Additional Items	
7.	G.I. pipe: 50 mm nominal diameter by 5 to 10 metres long typical, with bends and sockets as required.	1
8.	Copper braid: Bambach, duplex type, tinned, 400 amp rating, part number 48/10/0.254 (comes in 100 metre rolls from Bambach, Vic.)	1
9.	Denso material: Denso 300 paste, Denso 600 tape, 50 mm wide; Denso 931 PVC overwrap, 50 mm wide. Also Denso 430 Electrical Jointing Compound (Supplied by Denso Australia Ltd.) (Note 5)	As Required

MATERIAL LIST

Note 1: Quantities shown are for the worst case situation to achieve 10 ohms earth resistance. However, for locations of different soil resistivity, shorter length arms can be provided and the quantities reduced accordingly. Mild steel strap is supplied in 6 metre lengths, drilled as shown on K-7. (Suppliers of earth system components are: Ascom, Melbourne, Vic, Prince Engineering Ballarat, Vic and Hills Industries, S.A., etc).

Note 2: These lengths are approximations and may require alteration, depending upon individual site conditions.

Note 3: The length of the interconnecting conductor is dependant upon the distance between the underground equipment shelter and solar array pole. This distance may vary for each site location, but is typically 5 to 10 metres.

Note 4: This is an approximation as the exact quantity will be dependant upon the number of bolted joints required.

Note 5: For one typical installation the material needed is about 2.25 kg of Denso 300 paste, 50 metres of Denso 600 tape and 60 metres of Denso 931 PVC overwrap, plus 2.5 kg of Denso 430 Electrical Jointing Compound.

References : TPH 1553 EP "Installation Instruction For Remote Area Equipment Shelters For Optical Fibre Cable Repeaters".

CL 1608 OFC - Remote Area Repeater Maintenance Requirements, Sheets 1 and 2.