

## Company Directive

### STANDARD TECHNIQUE: CA1C/8

#### Relating to General Requirements Low Voltage Mains Jointing

This ST document contains all the General Requirements of Low Voltage Mains Jointing. These General Requirements detail the separate techniques which collectively form a Jointing Procedure.

This ST has not been written as a training document. It is not intended to be exhaustive in content and you must refer to your supervisor if you require training or instruction.

You shall work safely and skilfully, utilising the training/instruction you have already received, relating to the contents of this document and its cross-references.

You must make sure that you understand your job instructions and that you have the necessary tools and equipment for the job.

**Author:** Richard Summers

**Implementation Date:** February 2018

**Approved by**



**Policy Manager**

**Date:**

14 February 2018

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## **IMPLEMENTATION PLAN**

### **Introduction**

This document details the general tasks and procedures required to complete low voltage mains jointing and must be read in conjunction with specific STs for jointing techniques.

### **Main Changes**

GR3 amended to include a procedure for using temporary joints as part of short term fault restoration works.

### **Impact of Changes**

No major impact

### **Implementation Actions**

Team Managers need to make staff aware of these changes.

### **Implementation Timetable**

The document can be implemented with immediate effect.

## REVISION HISTORY

Document Revision & Review Table		
Date	Comments	Author
February 2018	<ul style="list-style-type: none"> <li>GR3 amended to include the use of Denso tape to waterproof temporary joints</li> </ul>	Richard Summers
May 2017	<ul style="list-style-type: none"> <li>Removal of PVC sheath as a method of protecting other cores when cutting cables – Only the approved insulated core guard wedge to be used</li> <li>GR 1 updated to reflect changes in ST:CA1Z</li> <li>GR43 requirements for gathering condition information are removed</li> <li>Clarification of Approved and Insulated tools</li> <li>Requirement for a dedicated Live Jointing Tool Box added</li> <li>Minor typo corrections</li> </ul>	Richard Summers
February 2016	<ul style="list-style-type: none"> <li>GR 2 Clarifications for Dead Working</li> <li>GR3 Rubber mats introduced to protect against bridging the insulation offered by Approved Dielectric Footwear (changed from Dielectric Wellingtons)</li> <li>GR3 Matrix 1 renamed and amended to reflect Additional Safety Equipment</li> </ul>	Richard Summers
October 2015	<ul style="list-style-type: none"> <li>GR3 Clarifications to the PPE Matrix, addition of dielectric wellingtons</li> <li>GR3 Insulation resistance limits included for PILC cables</li> <li>GR3 Testing Matrix added</li> <li>GR3 Minimum distance for shrouding and a requirement to shroud when using insulated / insulation piercing connectors is now added</li> <li>GR6 – Now includes a requirement to locate the centre of the wave when removing the PVC from Wavecon through cables.</li> <li>GR8 – Now specifies an insulated wedge for lifting the neutral earth wires on waveform cables</li> <li>GR13 – The metal knives are not to be used for removing lead sheaths. For cables up to 40mm diameter the lead shall be torn against a wire binder</li> <li>GR15 + GR16 Scotch 70 tape introduced as an option for terminating core / belt papers</li> <li>GR23 A torque controlled worm drive added for sheath bonds and an easier to cut tinned copper strap also added</li> <li>GR24 Single core cables will now be solid bonded</li> <li>GR28 – Ceramic knife referenced as the Approved insulated tool for removing insulation.</li> <li>GR32 – A requirement for all PVC sheathing within the joint shell to be abraded</li> <li>GR 44 Removed – Now contained in STCA1G</li> </ul>	Richard Summers
Sept 2013	<ul style="list-style-type: none"> <li>Amendment to drawing 6.34.1</li> </ul>	Richard Summers
Aug 2013	<ul style="list-style-type: none"> <li>Paragraph 34.3 - Cad welding for earth connections added</li> </ul>	Richard Summers

# **ST: CA1C/8      GENERAL REQUIREMENTS FOR LOW VOLTAGE MAINS JOINTING**

## **INTRODUCTION**

This ST document contains all the General Requirements of Low Voltage Jointing. These General Requirements detail the separate techniques which collectively form a Jointing Procedure.

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## GENERAL REQUIREMENT 1

### TOOLS, GENERAL CLEANLINESS AND ACCIDENT PREVENTION

#### 1.1 TOOLS

All tools with the exception of non-specialist tools / equipment must be tightly controlled and as such must be formally Approved before they can be use on the WPD network. All tools must only be purchased from our Approved tools suppliers.

Tools used for work on Low Voltage cables are split into four categories, Insulated tools for live working, safety equipment for live working, un-insulated specialist tools and non-specialist tools / equipment. For more details and a full list of Approved tools please see ST:CA1Z.

##### **Insulated Tools for Live Working**

All tools used for work on live conductors must be Approved and must be insulated for Live Working. These tools must be kept in a dedicated Live Jointing Toolbox. The use and Approval of insulated tools are tightly controlled and they must only be sourced from stock or from our Approved supplier.

##### **Safety Equipment for Live Working**

Safety Equipment for use whilst Live LV Jointing is used in addition to the PPE covered in the matrix in GR3 (ST:CA1C)

The use and Approval of Safety Equipment for Live Working is tightly controlled and they must only be sourced from stock or from our Approved supplier.

##### **Un-Insulated Specialist Tools**

These Specialist tools are required to complete specific Jointing tasks. They must **never** come into contact with a Live conductor.

The use and Approval of Un-Insulated Specialist tools are tightly controlled and they must only be sourced from stock or from our Approved supplier.

##### **Non-Specialist Tools / Equipment**

Non-Specialist Tools are considered as a lower risk and must be ordered from our Approved supplier. This allows the individuals to source items based on personal preference and quality. These Non-Specialist tools are required to complete specific Jointing tasks. They must **never** come into contact with a Live conductor

#### 1.2 SITE SAFETY

The majority of accidents can be avoided by taking reasonable care and precautions when performing normal duties associated with any work. Fortunately most of these accidents which do occur are of a minor nature, but there is always the risk of them developing into something more serious, with a consequent increase in the pain and suffering of the victim. Any accidents that do occur must be reported as soon as possible after the event.

Western Power Distribution spends many thousands of pounds each year to create the safest possible working conditions for its employees and take particular care in the selection and provision of tools and equipment which will improve safety in the working environment. Strict safety rules and procedures have been laid down with the sole purpose of safeguarding all who work on the distribution system and these must be observed at all times.

Despite all the efforts that have been made to provide safe appliances such as safety stands for gas torches, compound gloves, etc, accidents still occur. Most of these could be avoided if a little more care and forethought were to be exercised, e.g. gas furnaces should be sited conveniently near to the job but in such a position that they cannot be overturned, and also where they will not cause damage. Items of kit should not be left where they could be tripped over either by persons engaged on jointing work or by the general public. Gloves of the approved type should always be worn when handling hot or cold pour compound or when cutting or handling armour and cleaning cables.

Care should be taken to remove all oversheath's , scrap paper and hessian etc, resulting from cable stripping operations from joint pits as it occurs, to prevent the accumulation of inflammable material and reduce the fire risk in confined places.

When working on the highway appropriate warning notices must be displayed. These warning notices, barriers etc. shall comply with ST: HS14D. All barriers shall be erected and traffic cones positioned before commencement of work. By night obstructions and excavations must be marked by continuously lit yellow danger lamps.

Joint holes must be adequately fenced at all times and the fences must be substantial – not just token fences.

**Note:** -(a) A pile of earth is not a suitable barrier.

- (b) The Company's obligation to safeguard members of the public extends to all users including blind and infirm persons. To discharge this obligation the fencing must be such that it readily detectable by such persons. Approved barriers should therefore be erected around all excavations.
- (c) Where a footpath is substantially obstructed, then fencing must provide a passageway on the carriageway for pedestrians, protecting them from moving vehicles.
- (d) Where positive traffic control is necessary at small obstructions of short duration it must be by means of a manually operated stop and go boards. Flags must not be used for traffic control.

Paving stones must be removed and replaced with great care to avoid breakage. When re-laying paving stones it is essential that they should lie on an even bed, to prevent any rocking, and should be level with the surrounding stones.



When working on private premises care must be exercised to avoid accidental damage to consumers' property or internal decorations. Damage of this nature can often be avoided with a little forethought and particular attention should be paid to the removal of potential fire risks before a blow torch is used.

### **1.3 RISK ASSESSMENT**

The risks when conducting the jointing of cables are principally those of electric shock and burns. Jointing of cables can be achieved without exposure to significant risk but only following appropriate control measures identified in various risk assessments.

Site specific risks should be identified, controlled and recorded using the iPad app.

### **1.4 IDENTIFICATION OF LV CABLES**

When excavating around cables in the ground all cables must be assumed to be alive. In normal circumstances Jointers will be provided with service forms showing details of both the cable to be worked on and information concerning the position of other HV and LV cables in proximity to the working area, based on drawing office records. See Policy document POL: OS 4A, Location, Identification and Proving Dead of Underground Cables and Standard Technique ST: OS 4A, Location, Identification and Proving Dead of Underground Cables.

It is essential that strict compliance with the Company's Safety Rules, Policy Documents and Standard Techniques are maintained at all times and if any time doubt arises in the Jointer's mind he should cease work immediately and contact the Supervisor who will take appropriate action to positively identify the cable.

### **1.5 HYGIENE**

#### **General**

During any tinning or sweating operation involving resins or fluxes, fumes are given off. To certain people these fumes are obnoxious and can cause respiratory irritation. In other people, skin irritation and rash can occur, but this is equally possible with people handling solvents, oil, and other similar substances.

Where the majority of people are concerned these effects can be completely eliminated by taking a few simple precautions.

## **Avoidance of Fumes**

Care must be taken not to char or burn any PVC material as this will cause toxic gases to be given off.

During the tinning or sweating operation care should be taken to avoid the inhalation of large volumes of the fume given off, and tent flaps should be raised to permit the flow of clean air through the tent. At the same time the Jointer should position himself in such a way that the clean air flow carries the fumes away from his face.

## **Care of the Skin**

Before commencing work, hands and forearms should be thoroughly washed in cold water, using soap or a skin cleanser and then well dried.

A barrier cream should be applied to the hands taking particular care to rub sufficient in between the fingers and round the nails. Although approved gloves shall be worn while degreasing a cable, if inadvertent contact is made with the hands and the approved degreasing material then the hands must be washed and dried using the routine described above and a further application of barrier cream made.

As an additional precaution approved plastic coated gloves of a distinctive colour are available to Jointers for use during the fluxing, tinning and sweating operations. Care should be taken to prevent these gloves from becoming contaminated and they should be washed off with soap and water each time after use. Jointers are encouraged to use these gloves despite the slight restriction in movement that may be experienced as this can be overcome with practice.

**Note: -These gloves are not electrically tested and are not safe for live working.**

If work is to be carried out on live LV conductors the normal approved Safety Rubber Gloves should be worn when necessary, care being taken to wash the gloves off after use and to completely dry them using French Chalk.

## **1.6 FIRST AID**

All Jointers should be in possession of a small first-aid kit and items used should be replaced as soon as possible.

Details of the approved methods of artificial respiration are given in the Company's Safety Rules and every employee should familiarise himself with the procedures to be adopted. A knowledge of these methods could be of inestimable value at any time and may assist in saving life. Remember it could be YOURS.

## **1.7 USE OF PROPANE GAS**

### **General**

Gas containers should be stored at a temperature with the range of 13°C (55°F), to 30°C (85°F), and should never be exposed to a temperature higher than 43°C (110°F). Always keep the gas valve on the container turned off except when the gas is being used.

It is possible when turning on the gas to turn the handle several revolutions, this is unnecessary, one revolution being ample. This has the advantage that shutting the valve can be done quickly in an emergency.

Always keep the container upright and fastened securely in its carrying rack or cage during transit.

Containers, whilst in use, should be placed in position where there is good ventilation and never in a confined and unventilated place or joint pit. If the appliance will not reach the job when the container is in safe position, a longer flexible hose should be used.

For normal jointing work a length of 4m (3 metres minimum) of hose should cover the majority of circumstances without creating hazards of escaping gas or tipped appliance that might result from persons tripping over surplus hose.

Remember that the gas used is heavier than air and will therefore accumulate in pits and trenches in which it may travel along some distance from the point of release.

When the gas is no longer required for use it should be turned off at the valve on the container first, the gas allowed to burn itself out and the burner taps turned off last.

If the flame is accidentally extinguished do not attempt to relight the gas and do not allow any naked flame near, until the accumulated gas has been dispersed by opening ventilators, tent flaps or doors.

Do not meddle with any part of the gas apparatus.

A very small amount of gas can create an explosive mixture with air and small leakages of gas, therefore, are dangerous unless proper precautions are taken.

### **In Case of Fire**

If it is safe to approach the gas cylinder, turn off the main valve and remove the cylinder to a place of safety. If this cannot be done, call the Fire Brigade. In the meantime keep the cylinder as cool as possible by hosing it down from behind cover and keep the public well away.

## **1.8 USE OF HOT METALS**

Hot metals are no longer used in WPD, other than lifting the aluminium sheath on a Consac cable.

The use of gloves and a face visor is important when handling hot metals.

## 1.9 USE OF CLEANING/DEGREASING SOLVENTS

The use of solvents for both cleaning bitumized coated cable sheaths and the removal of grease etc to provide a good bond and seal for resin encapsulated joints is common to most jointing procedures and practices. It is therefore in the interests of health and safety that adequate precautions are taken when undertaking these processes which are common to both.

Your attention is drawn to the level of PPE required as the matrix given in General Requirement 3 whilst undertaking this operation.

### **Handling/Storage**

Solvents should only be dispensed from small containers; lids are to be tightly sealed whilst not in use and containers are stored secure in the upright position and away from sources of ignition.

Dispense only sufficient solvent onto the dry wipe, it is unnecessary, wasteful and potentially harmful to pour out large quantities which merely splash onto the ground.

Do not smoke whilst using solvents.

Contact of solvents with naked flames and red hot surfaces should be avoided.

### **Skin Contact**

Skin sensitisation or irritation is very infrequent, should contact occur with the degreaser, then immediately wash the area with soap and water. Unless the area to be washed, is the hands, **PVC gloves shall be worn** when carrying out this operation.

Remove any contaminated clothing and shoes; do not allow saturated clothing to remain in contact with skin for prolonged periods.

### **Splashes in the Eye**

Flush with water as needed, the use of eye protection may be worn.

### **Breathing of Vapour**

Ensure good ventilation particularly if working in confined areas.

### **Fire Hazard**

Solvents are flammable and should a fire occur the use of water fog, CO<sub>2</sub>, dry chemicals or foam are to be used to extinguish.

Avoid breathing the smoke and in and in confined areas suitable respiratory equipment is to be used.

## **Spillage**

Absorb small spills with dry sand or oil absorbent dispose as dry oil absorbent.

## **Disposal of empty containers**

Before disposal of the container the Jointer shall apply the Waste Disposal Label, from WPD's corporate print contract holder using Product code WPD/W400121.

These labels **shall** be used cover ALL the orange and black hazardous Dangerous Substances Directive (DSD) or the new red diamond of the Classification, Labelling and Packaging Regulations (CLP) labels, once the product in the respective container has been used or neutralised, thus allowing the re-labelled empty container to be placed in the normal waste bin.

### **1.10 GENERAL SAFETY PRECAUTIONS**

Attention is drawn to the other General Requirements in this Section which all have safety implications, but in particular to: -

- 19. Moisture Testing of Paper Insulated Cable
- 35. Degreasing Operation
- 37. Mixing and Pouring 3-Part Polyurethane Resin

## **1.11 COMPETENCE AND ACCOMPANIMENT**

Work on live underground cables shall only be conducted by Authorised Persons who hold a current WPD authorisation of LVUG, or by a person who holds LVUG UPS while under the Personal Supervision of an Authorised Person or Senior Authorised Person who holds a current WPD authorisation of LVUG.

Work on the structure and/or incoming cable conductors/connections of live cutouts shall only be conducted by Authorised Persons who hold a current WPD authorisation of COPLA when working on plastic insulated cutouts or COMET when working on metal clad cutouts, or by a person who holds COPLA UPS or COMET UPS while under the Personal Supervision of an Authorised Person or Senior Authorised Person who holds a current WPD authorisation of COPLA or COMET as appropriate.

Any person working on live underground cables and/or cut-outs shall be accompanied by a Competent Person holding, as a minimum, a current WPD authorisation of SMLV (a) or SMLV(c) or by a second Authorised Person, or a Senior Authorised Person.

## **GENERAL REQUIREMENT 2**

### **GENERAL JOINTING PROCEDURE – DEAD CABLES**

- 2.1 Unless a cable can be visually traced **throughout** its entire length, **all** its ends, including any connected services are fully isolated and disconnected from the Distribution Network, and the cable is proved dead with an Approved indicator in accordance with the Distribution Safety Rules, the cable must be worked on and be treated as LIVE. This LIVE working approach shall include the use of Temporary Earth Bonds, Shrouding and **all** LIVE Working Techniques. This method of work is designed to protect the Jointer from inadvertent backfeeds from either our network or customer connected generation.
- 2.2 When a cable is isolated, disconnected from the Distribution Network and proved dead in accordance with 2.1 Temporary Earth Bonds, Shrouding and Live Working PPE are not required. Other PPE specified in Matrix 3 must be used.
- 2.3 When jointing a DEAD cable to a LIVE cable all precautions for LIVE jointing, as detailed in General Requirement 3 must be carried out.

## GENERAL REQUIREMENT 3

### GENERAL JOINTING PROCEDURES SAFETY PRECAUTIONS AND TESTING REQUIREMENTS – LIVE CABLES

The provisions of General Requirement 1 also apply to the jointing of live cables.

The majority of LV jointing is carried out on live cables and precautions are therefore necessary to avoid personal injury and damage to the work.

The following points shall be observed for electrical safety: -

1. All cables shall be assumed to be live unless proved dead with an approved indicator. Where cables are or have been connected to the network they must always be jointed using live working techniques to protect the Jointer from inadvertent generation or back-feeds.
2. When working on a live low voltage cable all criteria of the Distribution Safety Rules shall be adhered to.
3. Any person receiving instructions to work on live cables shall be certain that he clearly understands the instructions and shall report any objections he may have regarding carrying out such instructions to the person issuing them. This person will then have the matter investigated and if necessary refer it to higher authority.
4. The required level of personal protective equipment and testing whilst jointing are given in the Matrix 1 and 2 overleaf.
5. Jointers shall comply with ST: HS8H, if using flame retardant longs and shirt then the shirt shall be tucked into the long trousers and the sleeves shall be down to the level of the wrists. If coveralls are being used then only flame retardant coveralls (one piece boiler suit) SHOPS No 41865 with sleeves down to the level of the wrists shall be worn when working on live low voltage cables. Reflective jackets will be worn as required by the New Roads and Street Works Act.
6. The work and work area shall be kept dry as far as is practicable. Where cables require jointing on a temporary basis (**max 72 hours**) the cable / joint can be protected from moisture using a minimum of 6 layers of Denso tape. To prevent the Denso tape contaminating the previously insulated cores, they must be protected by wrapping with PVC tape. Knit-mesh tape is then applied over the PVC to provide a **continuous** Earth screen around the conductors. The mesh is then connected to the Earth / Neutral Earth at both ends using cable ties. The Denso is then applied over the mesh and must then be smoothed out whilst wearing disposable gloves to provide a waterproof seal. The Denso must extend 100mm onto lead or PVC sheaths. A Caution Notice and cable marker tape should then be applied to the cable / joint. The temporary joint must not be backfilled.

### **WHEN REMOVING DENSO IT MUST ALWAYS BE UNWRAPPED AND MUST NEVER BE CUT FROM THE CABLE / JOINT**

In high risk locations consideration should be given to providing mechanical protection or fitting a resin filled joint.



7. Only approved tools and methods shall be used when jointing.
8. Tools used whilst jointing shall be kept clean and dry. On PILC cables the sheath shall be bonded across the joint using a temporary earth continuity strap before removal of the lead and this connection shall be maintained until the permanent continuity bond of the lead sheath is completed. This shall be done in accordance with General Requirement 11.
9. On Wavecon cables the continuity of the neutral/earth or earth is maintained by lifting the wave wound wires and spreading them out away from the working area as detailed in General Requirement 8.
10. On CONSAC cables the continuity of the neutral/earth sheath shall be maintained by opening the sheath as shown in General Requirement 12 /12a.
11. The methods of providing temporary shrouding for neutral/earths of Wavecon and CONSAC cables, the metallic sheath of PILC cables and other exposed metalwork are detailed in General Requirement 21.
12. The cable sheath, armouring or any other exposed earthed metal work on either side of the joint shall be covered with insulated material, for a distance of not less than 300mm on either side of the stripping dimensions. The position being taken from the PVC oversheath termination on Wavecon, Consac and PVC service cables, and lead sheath termination on PILC cables. This applies equally when using insulated or insulation piercing connectors
13. Any metallic gas pipes, water pipes or other earthed metalwork that is in the close proximity whilst jointing shall be temporarily covered with a rubber mat, insulated strip or sheeting whilst any jointing work is carried out. Plastic pipes shall be protected from flame where gas torches are used.
14. When opening and cutting a cable the neutral/earth shall always be maintained until the phases have been cut. When making a joint the neutral/earth will always be made first. Continuity to earth spikes will also be maintained.
15. Only one conductor shall be bared at a time.
16. Each core shall be re-insulated as soon as each stage of jointing is completed.
17. The following tests shall be carried out immediately before energising using an approved continuity / insulation resistance tester.
  - a) Continuity of the cable shall be tested to ensure all cores are connected and where required to prove identity. The ohms range shall be used when testing and a very low reading achieved.
  - b) Insulation Resistance of the cable shall be tested between core to earth, Neutral/earth and core to core ensure the insulation is of a healthy state. Cables must be discharged using a set of test lamps following this test.

The Megohms (MΩ) range shall be used for testing, for new cables values less than infinity (>999) will need to be investigated. For paper cables reading less than 1 MΩ must not be connected. Where readings are below expectation consideration should be given to isolation before connection before re-energising using a Fault-mate

**If the cable does not test satisfactorily, do not make the connection(s) and consult your Supervisor.**

18. The following tests shall be carried out using an approved test lamp:-

The standard test lamp is arranged to light fully when connected between phases and to glow at half brightness between phase and neutral. **The test lamp shall be proved before and after use.**

- (a) The cable shall be confirmed live or dead by testing with the lamp from earth to neutral phase to earth phase to neutral and between phases.
- (b) Before connecting two live cables together the test lamp shall be used to check that the cores to be jointed are in phase i.e. there is no glow when the lamp is connected between the two cores to be jointed.

When energising a dead cable by jointing to a live cable a test lamp shall be connected between a live core and the core to be energised (neutral / earth having been connected through first) there shall be no glow. (Load may also be indicated by a half light)

19. Whenever a cable (single or three phase) is cut or a dead cable is to be jointed to a live cable, all cores whether live or dead shall be temporary capped to prevent the core becoming live in the case of an unsuspecting backfeed.
20. Plastic coated gloves are supplied to Jointers for protection when degreasing fluxing etc. These are not electrically tested and **shall not** be relied on to give electrical protection.

When cutting a service cable checks shall be made both before and after the cutting operation to ensure the correct cable has been cut. A Testoscope is to be used for this purpose and for checking polarity on CNE cables.

21. Testing for polarity and phase rotation shall be in accordance with OP41 and ST: MI13K respectively. Matrix 2 shows the testing requirements for jointing work.

## **Matrix 1 Minimum PPE and Additional Safety Equipment Required when carrying out LV Jointing Work**

<b>Task</b>	<b>Comply with ST: HS8H.</b>	<b>Protective Footwear</b>	<b>Approved Dielectric Footwear</b>	<b>General Purpose Gloves</b>	<b>PVC Dipped Gloves</b>	<b>Electrical Gloves</b>	<b>Gloves (Disposable)</b>	<b>Gloves (Compound)</b>	<b>Full Face Visor</b>	<b>Goggles/Eye Protection</b>	<b>Ear Defenders</b>
1.Handling cables moving/lifting objects etc.	X	X		X						X	
2.Remove oversheaths (including PVC), armours and bedding from all cables	X		X*		X				X		
3. Cutting lengths of cable	X	X		X						X	
4.Fitting Temporary Earth Bonds– THROUGH CABLES	X		X*								
5.Fitting Temporary Earth Bonds – BETWEEN CABLES / EARTH SYSTEMS	X		X*			X			X		
6.Scoring and removal / opening of metallic Sheaths.	X		X*			X			X		
7.Forming and cutting N/E Wires. (live cables)	X		X*			X			X		
8.Fitting mechanical earth bonds to lead sheaths (temp earth bond fitted)	X		X*								
9.Installing Insulation Piercing Connectors.	X		X*			X			X		
10.Removing insulation on or near Live Conductors.	X		X*			X			X		
11.Testing on or near live conductors.	X		X*			X			X		
12.Connecting/Disconnecting Live/Dead Conductors. (inc Neutral Wires)	X		X*			X			X		
13.Dead Conductors . Fully Isolated– See GR 2	X	X								X	
14.Moving /Forming of N/E, E wires and N/E sheaths within a joint.	X		X*			X			X		
15.Using Solvents/degreasers on live cables.	X		X*		X				Visor or Goggles.		
16.Mixing Cold Pour Resin.	X	X					X		Visor or Goggles.		
17.Pouring Cold Pour Resin.	X		X*				X		Visor or Goggles.		
18.Handling Paraffin Wax.	X	X						X	Visor or Goggles.		
19.Changing of Live Cut-Out.	X		X*			X			X		
20.Operation of the “Izumi” Shear Bolt Tool – LIVE CONNECTORS	X		X*			X			X		X
21.Fitting Joint Shells	X		X*			X			X		

### **NOTES: -**

- Where site conditions dictate the use of additional PPE will be required e.g. safety helmet, high-visibility jackets etc.
- \* An approved rubber mat or shrouding must be used in addition to Approved Dielectric Footwear when kneeling or where there is a possibility of bypassing the insulation offered with other parts of the body.

## **Matrix 2 Testing requirements for LV Jointing Work**

	<b>Insulation Resistance Testing</b>	<b>Continuity Testing</b>	<b>Voltage testing</b>	<b>Polarity Testing</b>	<b>Earth Loop Impedance Testing</b>	<b>Phase Rotation</b>
Tests at Single Phase Cut-outs	X*		X	X	X	
Tests at Three Phase Cut-outs	X*		X	X	X	X
Making Single Phase Service Joint	X	X	AD	X	AD	
Making Three Phase Service Joint	X	X	AD	X	AD	AD
Connecting CT Panels	X	X	X	X	X	X
Opening a Through Main				X		
Installing a Link Box	X	X	X	X		X
Making a Mains Straight Joint (no load)	X			X		X
Making a Mains Straight Joint (with load)				X		X
Making a Mains Branch Joint (no load)	X			X		X
Making a Mains Branch Joint (with load)				X		X
Connecting Cables into a LV Feeder Pillar (no load)	X			X		X

AD – Advisable where doubts about the results exist

X\* - Required where meters and customer tails are to be connected (isolator / consumer unit switched off)

## **GENERAL REQUIREMENT 4**

### **SETTING UP AND MARKING CABLES**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

#### **General**

Sufficient room all round including the underside of the joint must be available to carry out the jointing operations safely and effectively. This requirement is particularly important for Consac cable where it is necessary to use the sheath cutting tool.

#### **Setting Up**

1. Set the cables in position straight and level and correctly aligned without undue strain. Tie and support the cables as necessary.
2. All earthed metalwork in the vicinity of the jointing position must be effectively insulated or screened to prevent contact. (See General Requirement 3).
3. Mark on each cable the intended centre line of the joint.
4. Using the dimensions given in the appropriate Jointing Procedure, mark the oversheath cut positions or, in the case of PILC cables, apply a wire binder around the cable at the serving cut and armour cut positions.

#### **Location of the Centre of the Wavecon Neutral/Earth or Earth Lay**

Before attempting to joint on Wavecon cable it is essential to locate the crest of the “wave” of the neutral/earth or earth wires so that the wires may be opened symmetrically on each side of the cable.

1. Mark the intended position of the centre of the joint.
2. Mark the oversheath 50mm each side of the centre mark.  
Remove the PVC oversheath to General Requirement 6.
3. Remove the oversheath between the circumferential cuts.
4. The wave formation of the neutral/earth or earth wires will be exposed, and the centre of the joint must correspond with a crest of the wave.

## **GENERAL REQUIREMENT 5**

### **METHOD OF OBTAINING HEIGHT FOR 3 AND 4 CORE WAVECON OUTDOOR TERMINATIONS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

Before the termination can be made off, the correct height must be obtained, although the termination for open wire, ABC and transformer fuses are identical it is important that the terminations are completed to ensure correct positioning once erected.

Whilst obtaining the height safety is paramount and only approved insulated rods and linen tapes are to be used, LV rubber gloves are to be worn when obtaining the height of open wire lines.

#### **5.1 Termination to Open Wire Line – Drawing GRD 6.5.1**

1. Position the insulated rod/linen tape at the base of the bottom “D” iron, and take the dimension to ground level and dimension ‘X’.
2. Lay the linen tape along the cable starting at ground level and follow the contour of the cable bend to the ‘X’ dimension position.
3. At this position add 850mm mark and cut the cable.
4. Support and straighten the cable.
5. Complete the termination to the relevant Jointing Procedure.

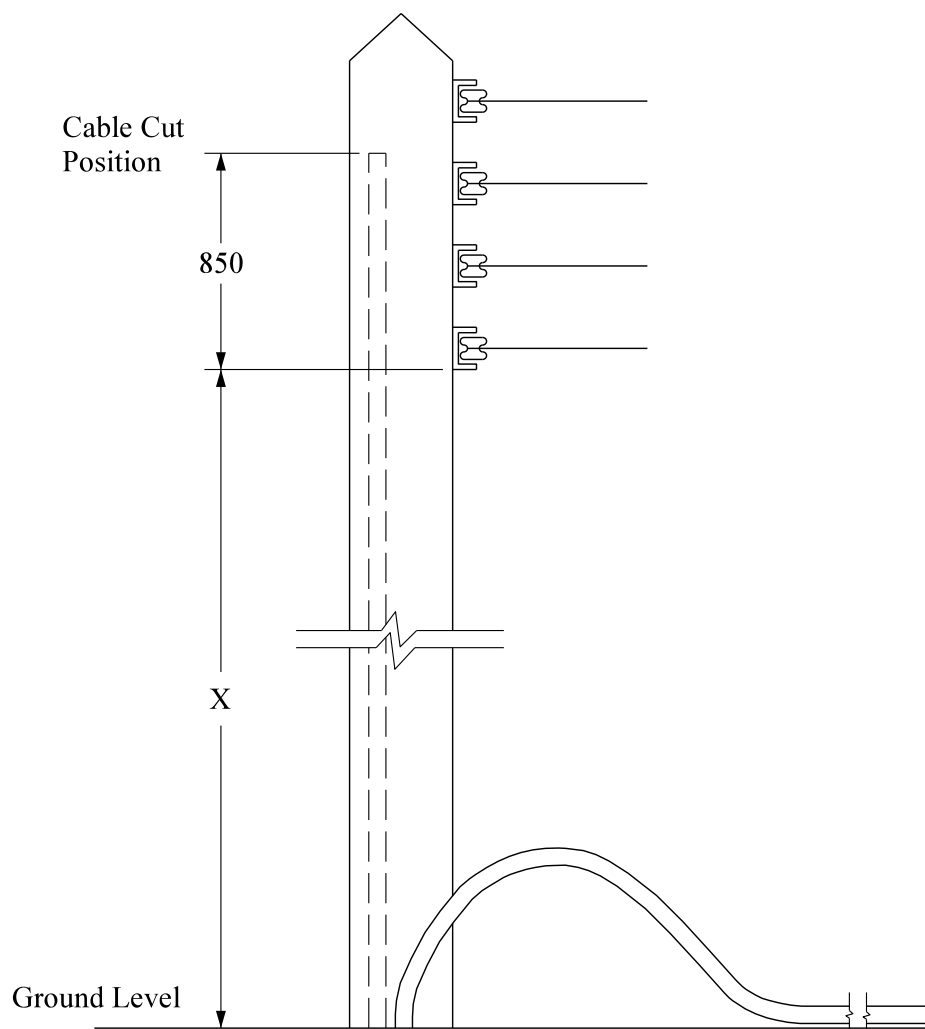
#### **5.2 Termination Transformer Fuses – Drawing GRD 6.5.2**

1. Position the insulated rods/linen tape in line with the top of the top fuse, and take the dimension to ground level – dimension ‘X’.
2. Lay the linen tape along the cable starting at ground level and follow the contour of the cable bend to the ‘X’ dimension position.
3. At this position add 1 metre, mark and cut the cable.
4. Support and straighten the cable.
5. Complete the termination to the relevant Jointing Procedure.


### **5.3 Termination to ABC Line – Drawing GRD 6.5.3**

1. Position the insulated rods/linen tape in line with the retaining bolt of the ABC wedge clamp straps, and take the dimension to ground level – dimension 'X'.
2. Lay the linen tape along the cable starting at ground level and follow the contour of the cable bend to the 'X' dimension position.
3. At this position mark and cut the cable.
4. Support and straighten the cable.
5. Complete the termination to the relevant Jointing Procedure.

All dimensions in mm



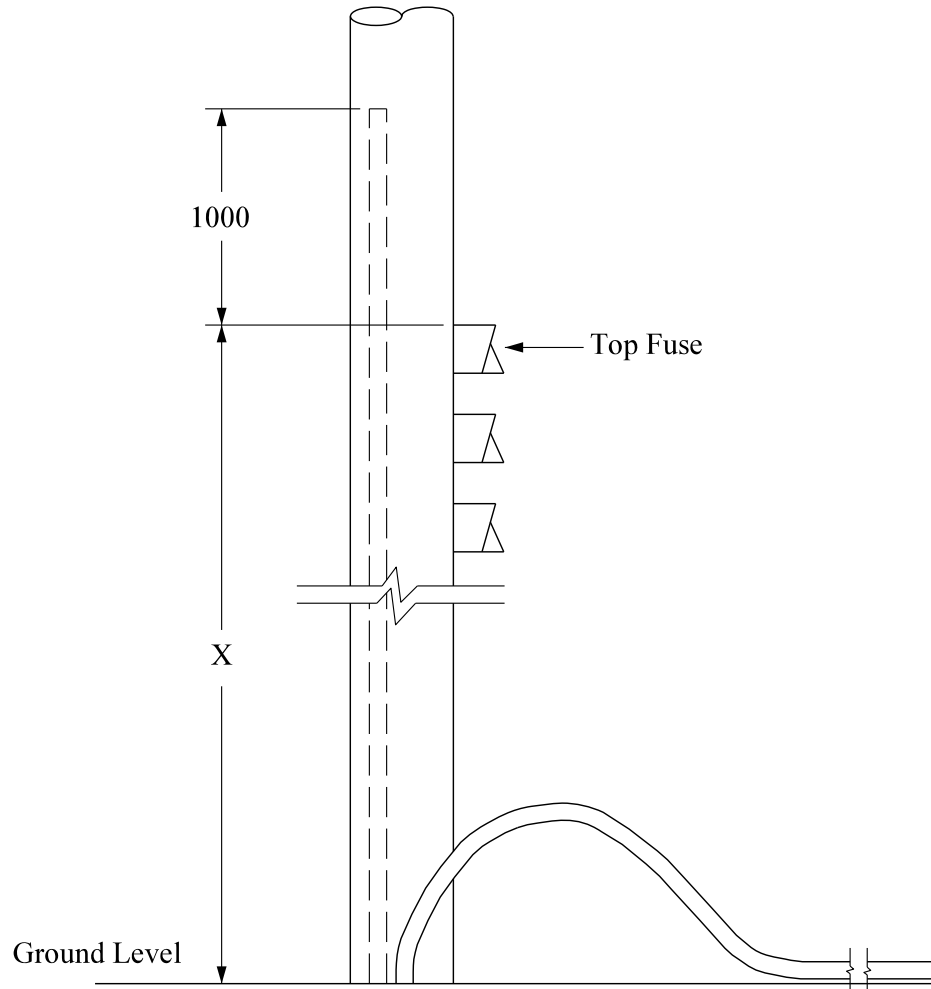
'X' = Ground Level To Bottom 'D' Iron  
Length At Which Cable Is Cut =  $X + 850$

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				Drg. No.  GRD 6.5.1.	
				Rev No	


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All dimensions in mm

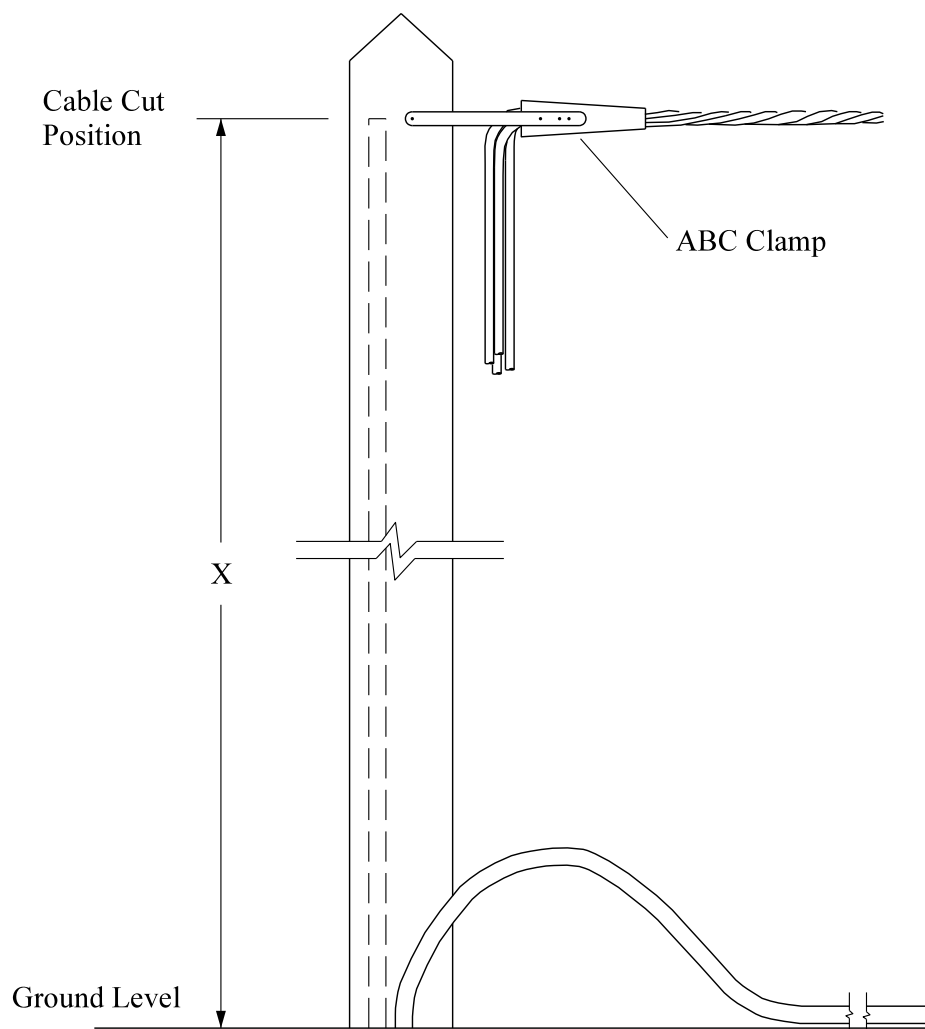


'X' = Ground Level To Top Of Top Fuse  
Length At Which Cable Is Cut =  $X + 1000$


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All dimensions in mm



'X' = Ground Level To ABC Clamp  
Length At Which Cable Is Cut = 'X'

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				METHOD OF OBTAINING HEIGHT FOR THREE AND FOUR CORE WAVECON OUTDOOR TERMINATIONS - ABC LINE	
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				GRD 6.5.3.	
				Rev No	

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## **GENERAL REQUIREMENT 6**

### **REMOVAL OF PVC OVERSHEATHS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

#### **6.1 Wavecon Cables**

When opening up Wavecon through cables it is important that the centre of a wave in the neutral earths becomes the centre of the joint. To do this a 150mm window of PVC must be removed to establish the centre position.

Using an aluminium sheath cutting tool make circumferential cuts, partially only, through the PVC oversheath at the required termination positions taking care not to damage the copper wires or any insulation under the oversheath.

In cold weather, or if necessary use a gas-torch to warm the area of PVC sheath to be removed. When the PVC sheath is warm use a knife with the blade flat to the cable side making a longitudinal cut between the two circumferential cuts, this is achieved with a slicing or shaving action. Remove the sheath by pulling it from the cable with an unwrapping action.

Carefully unwrap and remove the oversheath ensuring that it does not tear beyond the circumferential cuts.

**Note:** - On no account must the blade tip be placed directly into the PVC oversheath, and care must be taken to ensure that underlying conductors and their insulation are not damaged.

#### **6.2 Consac Cables**

Using an aluminium sheath cutting tool make circumferential cuts, partially only, through the PVC oversheath at the required termination positions taking care not to damage the aluminium neutral sheath.

In cold weather, or if necessary use a gas-torch to warm the area of PVC sheath to be removed. When the PVC sheath is warm use a knife with the blade flat to the cable side making a longitudinal cut between the two circumferential cuts, this is achieved with a slicing or shaving action. Remove the sheath by pulling it from the cable with an unwrapping action.

Examine the bituminous coating on the aluminium sheath. If there are large areas of sheath free from bitumen it must be reported to the Supervisor in charge before work on the joint is continued.

**Note:** - On no account must the blade tip be placed directly into the PVC oversheath, and care must be taken to ensure that underlying conductors and their insulation are not damaged.

Using a gas torch warm the bituminous coating and thoroughly clean the exposed aluminium sheath using an approved degreaser.

### 6.3 **PVC Insulated Service Cables**

When it is required to remove the PVC oversheath from PVC insulated service cables an approved stripping tool **shall** be used. Hook the stripping tool over the service cable and make a circumferential cut in the PVC oversheath where it is to be terminated. A cut should then be made along the oversheath from the termination position to the cable end. Beginning at the cable end reel off the oversheath from the cable.

### 6.4 **Alternative Method of Removing PVC Oversheaths**

Where the work area may be restricted whilst removing the PVC oversheath, an alternative to the aforementioned specialised tooling for making the circumferential cut is the use of Kevlar string (or whipping thread).

The Kevlar string is used in the form of a “garrotte” around the cable oversheath, with a sawing action the Kevlar will penetrate through the PVC oversheath without causing damage to the underlying conductors or their insulation.

Care is to be taken on split concentric PVC sheathed neutral wires, although the cellophane belt papers should prevent penetration to these conductors.

**Care must be taken when cutting PVC oversheaths to ensure that underlying conductors (and their insulation) are not damaged.**

## **GENERAL REQUIREMENT 7**

### **REMOVAL OF WATER FROM WAVECON CABLES WHILST JOINTING**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

Due to the PVC oversheath of Wavecon and PVC concentric service cables being loosely extruded and the absence of any water blocking mastic between the inner of the sheath and the copper wires, water travels easily through the cable.

This becomes evident at times when the PVC oversheath has become punctured and allowed the ingress of water to travel some distance along the cable from the point of damage.

It is of the utmost importance for the safety of the craftsman that the cable remains dry whilst jointing and to ensure reliability of the completed joint that resin encapsulation is undertaken whilst the cable is dry, otherwise the resin will not cure and becomes porous, with subsequent failure of the joint.

Having opened the cable at the joint position ascertain from which end the water is draining from and adopt one of the following methods, there may be a need to vent both sides of the joint position.

#### **7.1 Water Under PVC Oversheath – Drawing GRD 6.7.1**

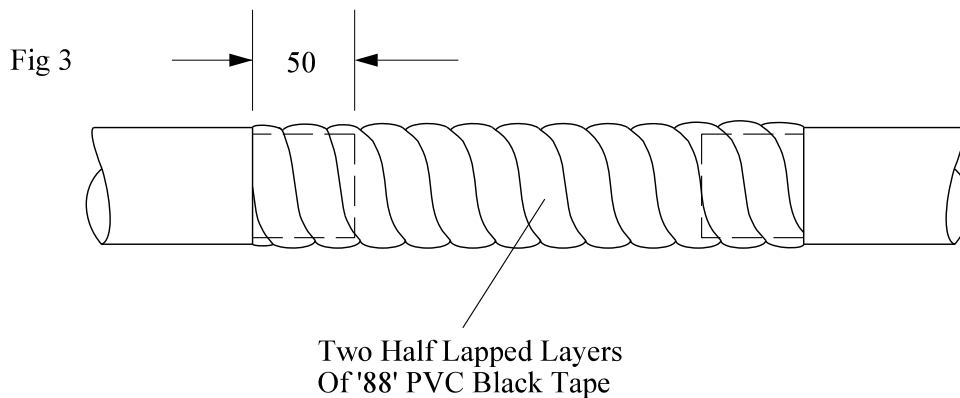
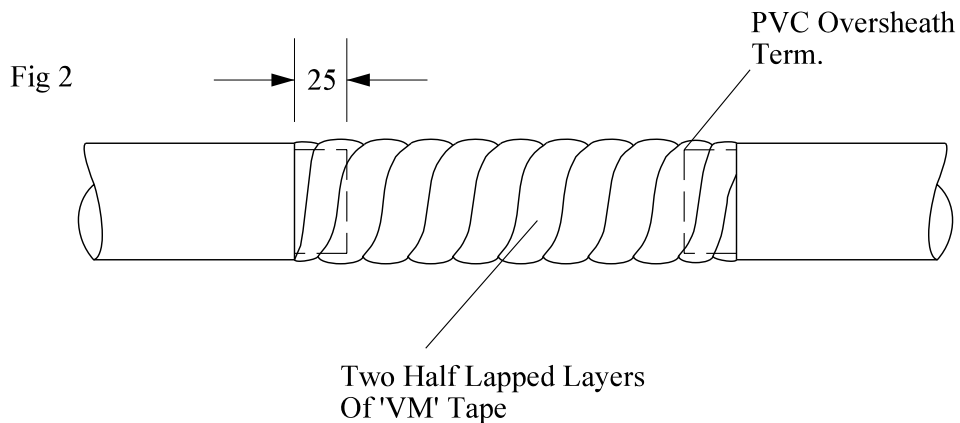
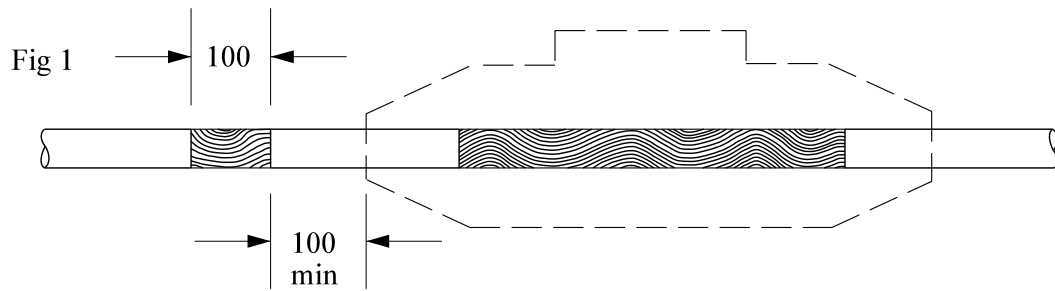
1. At a distance 100mm from the proposed end of the joint shell remove a 100mm length of PVC oversheath –Fig 1.
2. Allow water to drain, dry the interior of the joint and complete to the relevant Jointing Procedure.
3. Replace the PVC oversheath and apply two half lapped layers of ‘VM’ tape overlapping onto the oversheaths by 25mm – Fig 2.
4. Apply two half lapped layers of ‘88’ black PVC tape over the previously applied ‘VM’ tape, overlapping onto the PVC oversheaths by 50mm – Fig 3.

#### **7.2 Water Between Cores – Drawing GRD 6.7.1**


1. At a distance 100mm from the proposed end of the joint shell remove a 200mm length of PVC oversheath – Fig 1.
2. Apply tinned copper wire binders to the copper wires at the PVC oversheath termination – Fig 2.
3. On the underside of the cable ease the copper wires apart using an approved insulated wedge to form an opening – Fig 2.

4. Using an approved insulated wedge split the rubber bedding to form a gap and if possible from an opening between the cores – Fig 2.
5. Allow the water to drain, dry the interior of the joint and complete to the relevant Jointing Procedure.
6. Fill the gap made in the rubber bedding using Scotchfil putty pushing well into the cavity – Fig 3.
7. Relay the copper wires to there original position.
8. Remove the tinned copper wire binders and apply one half lapped layer of tinned copper mesh covering the copper wires between the PVC oversheath termination - Fig 4. (GRD 6.7.3)
9. Replace the PVC oversheath and apply two half lapped layers of ‘VM’ tape overlapping onto the oversheaths by 25mm –Fig 5. (GRD 6.7.3)
10. Apply two half lapped layers of ‘88’ black PVC tape over the previously applied ‘VM’ tape, overlapping onto the PVC oversheaths by 50mm –Fig 6. (GRD 6.7.3)

All dimensions in mm

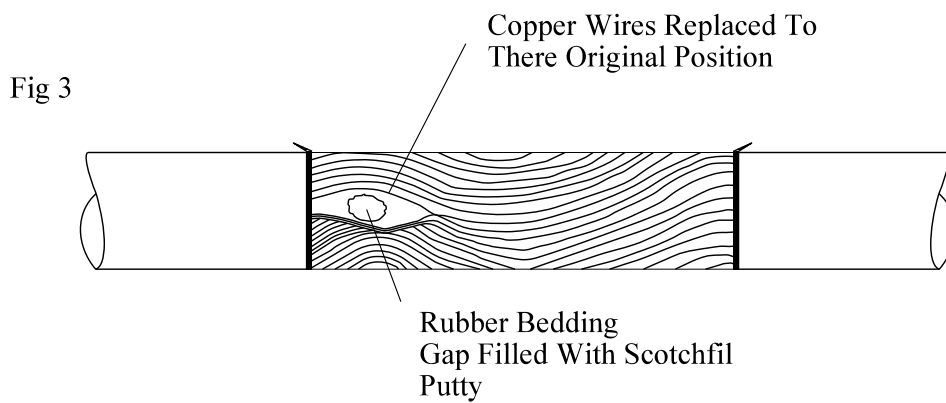
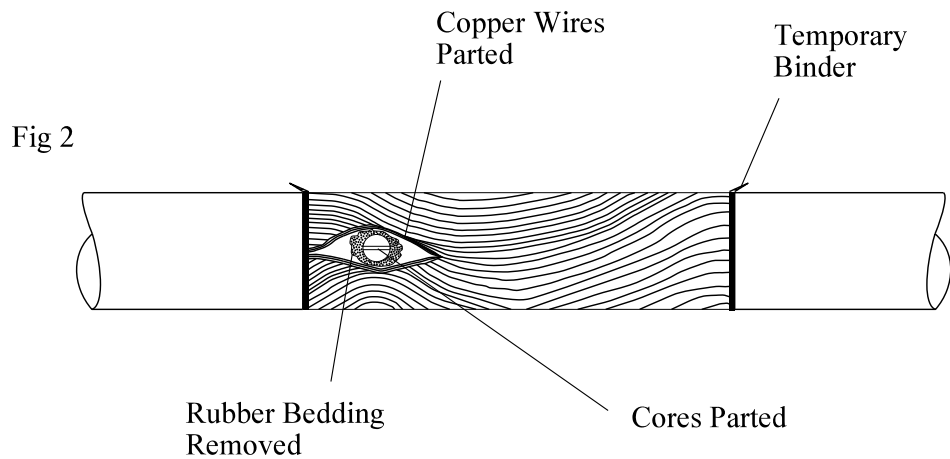
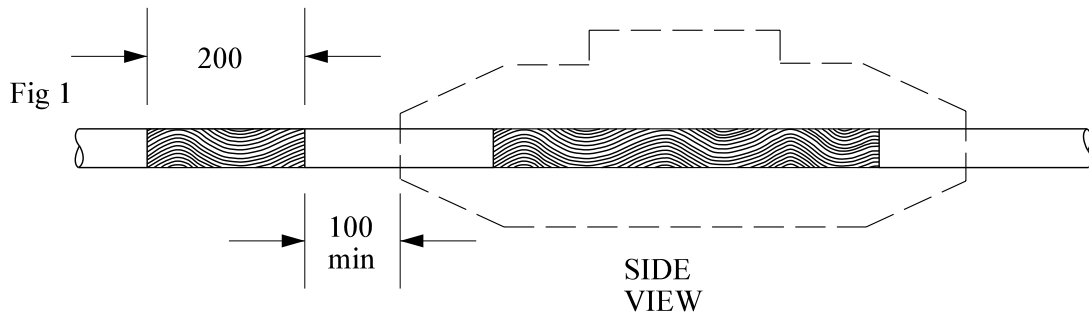


SIDE VIEW


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All dimensions in mm



NOTE:- Figs 2 & 2 Are Viewed From Underside Of Cable

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All dimensions in mm

Fig 4

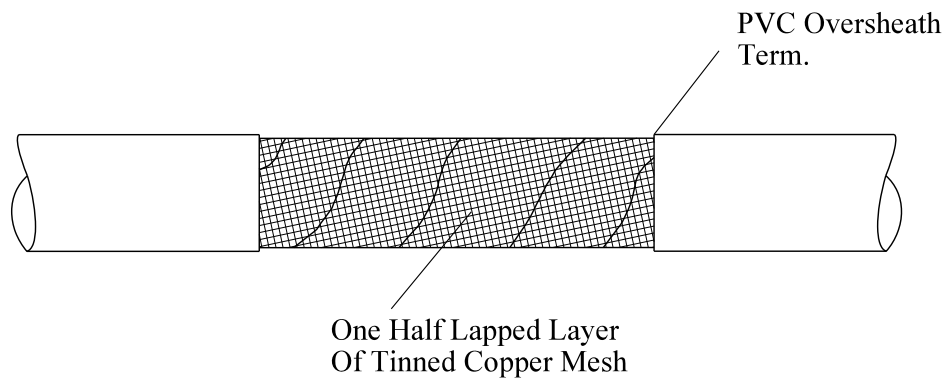


Fig 5

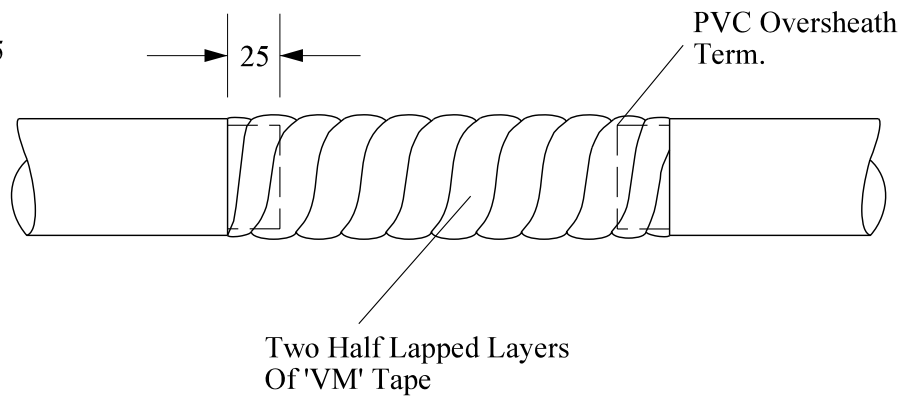
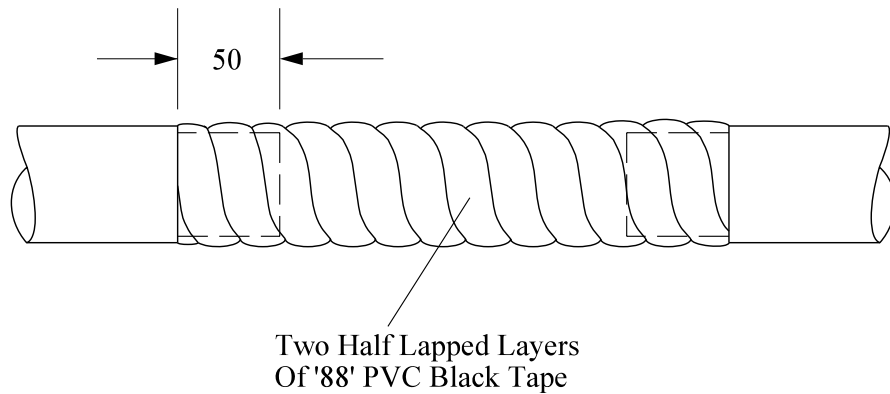



Fig 6



SIDE VIEW

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## **GENERAL REQUIREMENT 8**

### **PREPARATION OF NEUTRAL/EARTH WIRES OF 3 AND 4 CORE WAVECON FOR JOINTING**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

#### **8.1 Joints where the 3/4 Core Wavecon neutral/earth or earth wires are formed into two bunches**

Joints in this category include:-

3/4 Core Wavecon mains service joints

3/4 Core Wavecon stop ends

3/4 Core Wavecon straight joints

3/4 Core Wavecon branch joints

Apply a 3 turns of 16 swg tinned copper wire binder around the neutral/earth or earth wires adjacent to the PVC oversheath termination.

Commencing at the centre of the joint, carefully lift each wire from the rubber bedding using an approved insulated wedge, such that they can be divided into two equal bunches each side of the cable.

Straighten each wire and form them into two conductors, one each side of the cable in accordance with the relevant drawing.

#### **8.2 Joints/Terminations where the 3/4 Core Wavecon neutral/earth or earth wires are formed into one bunch**

Joints in this category include:-

Consac main to 3 core Wavecon branch joints

3/4 Core Wavecon to Pilc straight joints

Pilc main to 3/4 Core Wavecon branch joints

3/4 Core Wavecon terminations

2 Way and 4 Way Link Disconnection Boxes

Apply a 3 turns of 16 swg tinned copper wire binder around the neutral/earth or earth wires adjacent to the PVC oversheath termination.

Commencing at the end of the cable, carefully lift each wire from the rubber bedding using an approved insulated wedge.

Determine the most appropriate position for a single earth or neutral/earth conductor to be run.

Straighten the wires and form into a single conductor, bind together with cable ties or a PVC tape binder (blue or green/yellow) at intervals not more than 100mm apart.

### **8.3 Plain concentric service cables – joints/terminations**

Straighten the neutral/earth conductors, form a small birdcage adjacent to the PVC oversheath termination, form the wires into a single conductor.

### **8.4 Split concentric service cables – joints/terminations**

Straighten and form the bare earth wires and the approved insulated neutral wires into two single conductors forming a small birdcage adjacent to the PVC oversheath termination.

## **GENERAL REQUIREMENT 9**

### **REMOVAL OF RUBBER BEDDING OF WAVECON CABLE**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

1. Mark the rubber bedding cut position.
2. Apply a cable tie around the rubber bedding at the cut position.
3. Working towards the cable tie, cut the rubber bedding away with an approved insulated wedge.
4. Tear the rubber away against the cable tie.
5. Remove any taping around the cores using a core knife. Ensure that the cutting edge of the knife is facing away from the core insulation.
6. Remove the cable tie before commencing the next operation.
7. Thoroughly remove all traces of rubber from the core insulation, using an approved degreaser.

## **GENERAL REQUIREMENT 10**

### **REMOVAL OF SERVING, ARMOUR AND BEDDING FROM PILC CABLES**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

1. At the serving termination position apply a wire binder around the serving. Cut around the serving at the binder with a hook knife using sufficient force to cut the serving but not to damage the armour.
2. Remove the serving to the cut position.
3. At the armour termination position, apply a wire binder around the armour, cut through the outer armour tape with a hacksaw fitted with a depth gauge.
4. Remove the outer armour tape completely.
5. Repeat the operation for the inner armour tape, taking extreme care to ensure that the lead sheath is not damaged.
6. Remove the hessian bedding by cutting with a hook knife along the side of the cable, which will allow the bedding to be unwrapped. This operation may be helped by warming the bedding with a gas torch.
7. Warm the paper bedding over the lead sheath and remove.
8. Warm the bitumastic coating over the lead sheath and the armour tapes until it just begins to melt, with a gas torch. Remove the bitumastic coating and clean the lead sheath and armour tapes with approved degreaser soaked rags.
9. Finally clean with a dry rag.

## GENERAL REQUIREMENT 11

### EQUI-POTENTIAL BONDING OF JOINTING POSITIONS.

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

The procedure is designed to provide protection for personnel by maintaining electrical continuity across breaks in the sheathing and or armour during jointing or repair operations on underground cables. This will ensure that the earthing of connected equipment is not impaired; in addition it will bring all exposed metallic cable sheaths/armours to the same potential.

This general requirement applies to straight joints, branch joints and terminations on LV Service, LV Mains, 11kV, 33kV, 66kV, Multicore, Swedat and Pilot underground cables whether these cables are connected to WPD's electrical network or any other private network. It applies equally to cables having a continuous metallic sheath and those where earth continuity is provided via the armouring of the cable.

#### 11.1 Approved Equipment

The temporary continuity connectors consist of bonds of flexible tinned copper braid, which are connected to the armour or sheath by special clamps. The braid has a primary insulation of clear polythene tubing.

Approved electrical gloves complete with outer leather protector.

#### 11.2 Application

The temporary continuity connectors or “Bonds” are used in the following way: -

Examine the Hepbond to ensure the insulation is intact and clean.

##### (i) Straight Through Joints

After the cable sheath, armour or neutral earth wires have been exposed during the early stages of making a straight joint and before they are cut, a clean temporary continuity connector shall be applied and properly tightened to the cleaned sheath, armour or neutral earth wires, at a position where it will not interfere with the jointing procedure. **It shall not be removed until the permanent earth conductor has been re-established across the joint.**

In the case of the cables that are disconnected from one another, then all work involving the cable sheath/armour carried out prior to the temporary continuity connector being fitted, shall be undertaken using the approved personal protective equipment (PPE) as detailed in the matrix given in General Requirement No. 3. Once the temporary continuity connector has restored the earth continuity then the jointing can proceed in accordance with the relevant jointing procedure.

The third or free end of the temporary continuity connector should be placed safely out of the way, e.g. by putting it around some clean part of the cable.

## (ii) Branch Joints

In the case of branch joints the procedure to be followed, will be the same as for the straight through joint, with the following exception: -

All work associated with the removal of the PVC oversheath/serving carried out prior to the temporary continuity connector being fitted to the sheath/armour of the cables to be branch jointed, should be undertaken using the approved PPE as detailed in the matrix given in General Requirement No. 3. Once the temporary continuity connector has established the earth continuity between the branch cable and main cables, then the jointing can proceed in the normal manner. **This bonding must be carried out before the sheath of the main cable is cut.**

## (iii) Terminations

After the cable sheath, armour or neutral earth wires have been exposed during the early stages of making a straight joint and before they are cut, a clean temporary continuity connector shall be applied and properly tightened to the cleaned sheath, armour or neutral earth wires, at a position where it will not interfere with the jointing procedure. **It shall not be removed until the permanent earth conductor has been re-established across the termination.**

All work associated with the removal of the PVC oversheath/serving carried out prior to the temporary continuity connector being fitted to the sheath/armour of the cables to be terminated, should be undertaken using the approved PPE as detailed in the matrix given in ST: CA1C - General Requirement No. 3. Once the temporary continuity connector has established the earth continuity between the main cable and the switchgear/transformer, then the jointing can proceed in the normal manner.

The third or free end of the temporary continuity connector should be placed safely out of the way, e.g. by putting it around some clean part of the cable.

## 11.3 Removal

Once the Jointer reaches the stage where the permanent mechanical earth connection has been correctly fitted within the joint or termination, the temporary continuity connector can be removed.

## GENERAL REQUIREMENT 12

### OPENING THE ALUMINIUM SHEATH OF A CONSAC CABLE

Before commencing the level of PPE required for this operation shall be as matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

For all Consac cable joints it is essential to remove the aluminium neutral earth sheath from the cable using the approved procedure. This ensures that when the sheath is removed on an intermediate length, continuity of the neutral earth is maintained, and for joints made at cable ends, the sheaths can be readily joined without the use of bonding strips.

Great care must be taken over the removal of the sheath to ensure that it does not tear during the unwrapping process and that it is in the correct position when the unwrapping is complete.

Before commencing to cut the sheath with the tool provided, the cable must be straight and reasonably free from kinks or distortion. If the cable is badly distorted it may not be possible to remove the sheath, using the tool. Cases of doubt must be referred to the supervisor.

#### 12.1 Opening the cable at an intermediate point in its length – Drawing GRD 6.12.2

The following is the approved procedure for opening the sheath of a Consac cable at an intermediate point in its length.

1. Ensure that the sheath is completely clean.
2. Mark the centre line of the joint with an arrow pointing in the opposite direction to which the aluminium sheath is to be unwrapped.
3. On the opposite side to that to which the unwrapped sheath will point make three pencil lines parallel to the axis of the cable as shown in Fig.1.

The first line is half-way down and the other lines approximately 13mm above and below the first.

4. Place the approved sheath cutting tool fitted with the wheel appropriate to the cable size onto the cable (GRD 6.12.2) in such a way that the back of the tool faces in the opposite direction to the arrow previously marked, with the cutting wheel at the **bottom** of the cable.
5. Move the tool to one end of the joint so that the edge of the nylon pad touches the PVC sheath and adjust the cutting wheel to the required angle of 60°.
6. With the cutting wheel at the **bottom** of the cable, tighten the screw handle of the tool until the cutting wheel just touches the sheath and then give the screw handle an additional ½-turn. This will ensure that the first helical cut made along the sheath is decisive, and will tend to round up any minor deformation. It will also help to prevent the tool “double-tracking” on the return cut.



7. Rotate the tool **carefully almost two revolutions** until the cut reaches the lower pencil line. Note that the back of the tool must lead the cutting wheel during this operation. This avoids difficulties caused by slight “flexing” of the tool.
8. Run the tool back to the PVC oversheath without further tightening of the screw handle.
9. Repeat the cutting process, gradually deepening the cut, until sufficient depth is obtained.

For 185 sq mm cable, this point is reached when the shoulders of the cutting wheel with the cutting depth of 1.51mm begin to mark the sheath on each side of the cut.

For 95 sq mm cable, using the correct 95 Consac cutting wheel, this point is reached when the shoulders of the cutting wheel with a cutting depth of 0.9mm begin to mark the sheath on each side of the cut.

10. Reverse the 60° angle of the cutting wheel and repeat the process from the other end of the joint.
11. Set the cutting wheel to be parallel to the axis of the cable. Make three cuts along the pencil lines between the helical cuts as shown in Fig 2. It will be necessary to use the T-handle of the cutting wheel during this operation. The depth of cuts should correspond with the depth of the helical cuts.
12. Remove the rectangle of sheath denoted by the shaded area(s) shown in Fig.2 by employing the following method:

Lightly abrade the rectangular strip with a file and thoroughly tin the surface with abrasive solder. Plumb a stick of Grade ‘H’ metal to the tinned surface, and **after allowing two or three minutes for cooling**, carefully break out the rectangular strip using the stick of metal as a lever.

During the tinning and plumbing operation a face visor must be worn to avoid injury if hot cable impregnate is ejected through the partially cut sheath.

13. Carefully lift the edge of the sheath, using an all approved insulated hook tool, along its full length, until clear of the belt papers. At this stage, the hooked lifting tool may be used to complete the unwrapping.

**Note: - To avoid damage to the belt papers, the steel hooked lifting tool must not be used to lift the edge of the sheath.**

14. Unwrap the sheath, ensuring that it tears neatly along the helical cuts. On no account must the sheath be completely severed since the neutral sheath may become energised at working voltage presenting a dangerous situation to both the Joiner and consumers.

When the sheath unwrapping is complete the sheath should extend horizontally on the required side (normally away from the Joiner), with the inner surface uppermost.

15. Carefully flatten the unwrapped aluminium sheath using two mallets and remove any sharp edges with a file.
16. Thoroughly clean the inside and outside of the sheath with approved degreaser.
17. Remove shaded area (b) by breaking out along cut line – Fig 3.
18. Reduce the width of longitudinal sheath to the same as the angled portions by removing shaded area (c) – Fig 3.
19. Remove any sharp edges with a file.

## **12.2 Opening the sheath at the cable end**

For joints where the sheath is initially discontinuous, (eg straight joints) the sheath cutting is done in a similar manner to that described above, except that the helical cuts are made in the position to suit the particular joint, and the longitudinal cuts extended to the cable end.

Care must be taken to make sure that the cuts are made so that the unwrapped sheaths may be joined.

All dimensions in mm

Fig 1

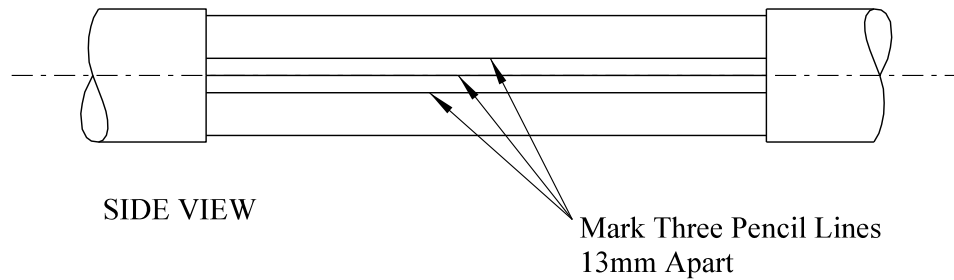
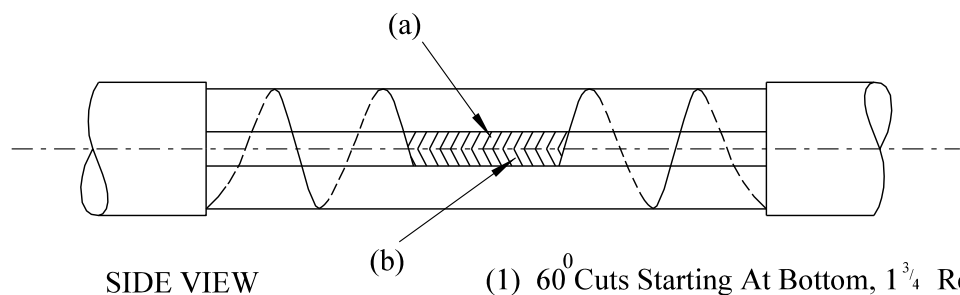


Fig 2

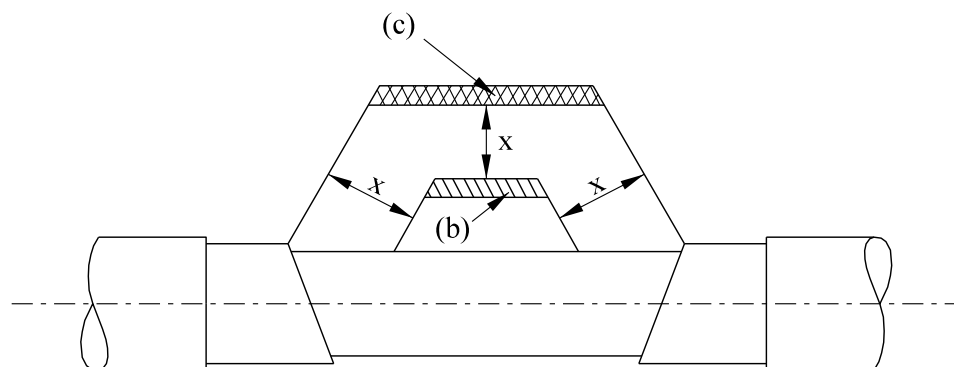


(1) 60° Cuts Starting At Bottom,  $1\frac{3}{4}$  Revs  
Ending On Lower Pencil Line

(2) Three Longitudinal Cuts On Pencil Lines

(3) Remove Shaded Portion (a)


Fig 3



(1) Unroll Sheath To Horizontal Position  
(Away From Jointer)

(2) Remove Shaded Strip (b)

(3) Mark Off And Remove (c) Such That  $x = x = x$

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Drawn	RJB	06/12			
Checked				Title      OPENING OF ALUMINIUM NEUTRAL EARTH SHEATHS OF CONSAC CABLES	
Approved					
SCALE      N.T.S.				Drg. No.  GRD 6.12.1	
				Rev No	

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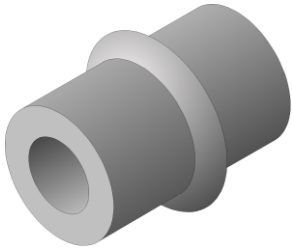
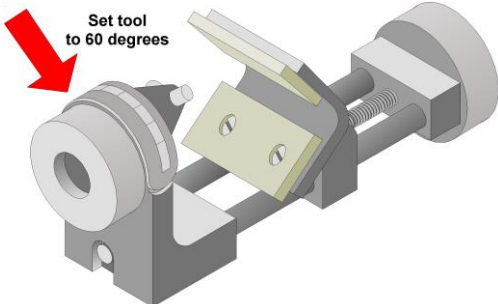
## GENERAL REQUIREMENT 12A – MIDLANDS AREA ONLY

This General Requirement is only intended for Jointers who have been trained in this method of sheath removal. South / South West Jointers must continue to use the Trapezoidal method described in General Requirement 12. Before attempting to work on a CONSAC cable you must have completed a formal training course and have all of the approved tools.

For joint dimensions and all other techniques associated with jointing CONSAC cables please use the relevant jointing ST. If in doubt refer to your Supervisor.

### 2. REMOVING THE ALUMINIUM SHEATH

From this point onward, wear both eye and hand PPE.

<p>2.1 Mark the Aluminium sheath at the cable joint centre and make two further marks at 60 degrees to form an arrow – this arrow must point towards the operative.</p>	
<p>2.2 Select the correct cutting wheel for the approved sheath stripping tool according to the cable cross sectional area.</p> <p>70mm – 120mm = 0.9mm Wheel</p> <p>150mm – 240mm = 1.51mm Wheel</p>	
<p>2.3 Set the angle of the sheath cutting tool to 60 degrees, using the front control wheel and scale.</p>	

2.4 Using the rear pressure control wheel, open then close the tool onto the first of the 60 degree marks. Apply light pressure then rotate the tool outward along the cable until it butts up to the PVC sheath edge, this should occur at tool bottom dead centre.



2.5 Repeat this operation, moving the tool forward and backward along the cable, gradually increasing the pressure using the rear wheel. Continue this process until scuff marks from the shoulders of the cutting wheel appear along the edges of the cut, then stop.

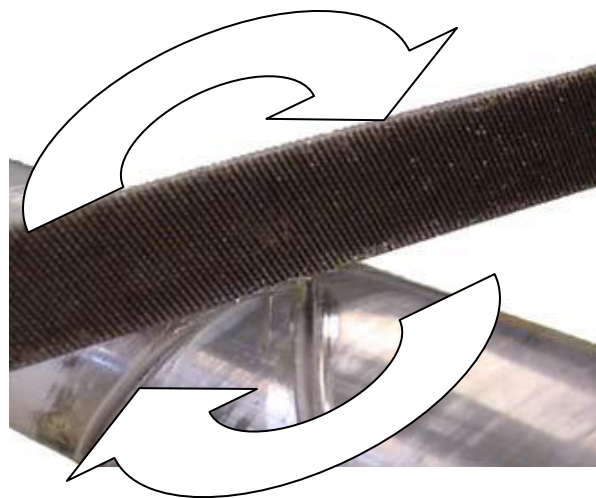


2.6 Remove the tool and re-set the cutter angle to 60 degrees on the opposite hand. Re-fit the tool and repeat operations 2.4 and 2.5. Remove the tool on completion.

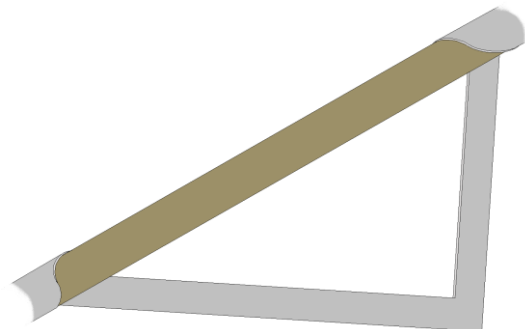


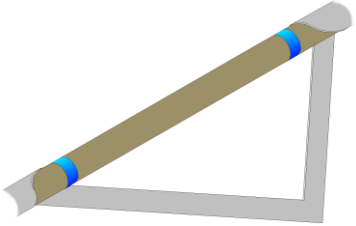
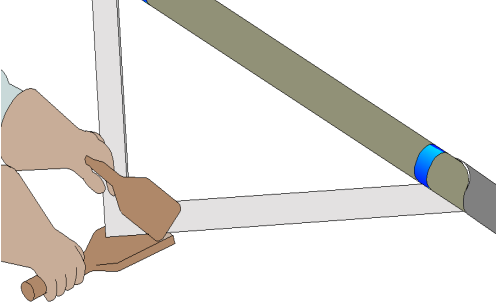
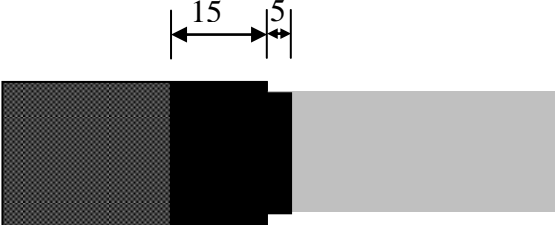
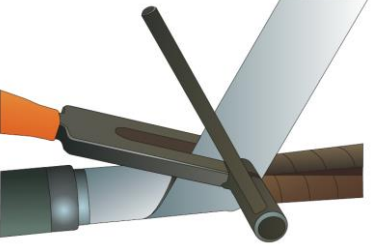
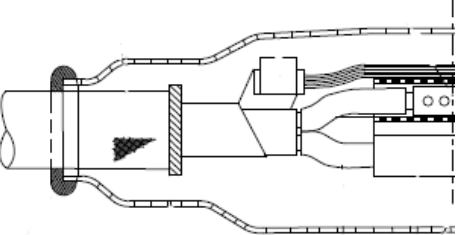
2.7 At the point where the two tool cuts join, use the edge of a **150mm** half round file to deepen the cut on both sides until the underlying papers just begin to appear. Once the papers start to appear stop filing. *The flat side of the file must point towards the inside of the arrow.*

Once filing is complete the point of the sheath can be lifted by holding the file into the cut and rotating as shown in the picture



2.8 The lifted point can then be gripped with pliers and then tapped with an approved insulated hammer. Wearing gloves unpeel the Aluminium sheath from the cable, until the ends of the cut are reached. The sheath should now appear as shown in the illustration, pointing away from the operative.



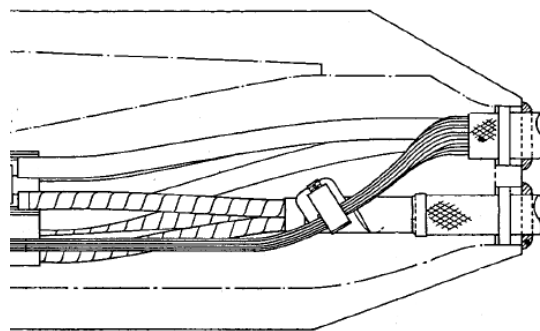
<p>2.9 Apply twine binders at the points where the underlying papers are to be terminated.</p>	
<p>2.10 Beat the cut part of the sheath flat with a pair of wooden beaters.</p>	
<p>2.11 Clean and abrade the outer sheath in accordance with General Requirement 32 and apply four turns of 3M 5313 tape to seal the outer sheath</p>	
<p>2.12 Where a holes is required (mains branch joints and service joints) these can be punched in the Aluminium sheath, using approved special purpose tool</p>	
<p>2.13 Arrangement of the N/E connections in straight joints - using the TA type connectors (bridge with earth bond before cutting the sheath). As per Jointing ST's</p>	

2.14 Arrangement of the N/E connection in mains branch joints.

**Minimum bridging conductor sizes**

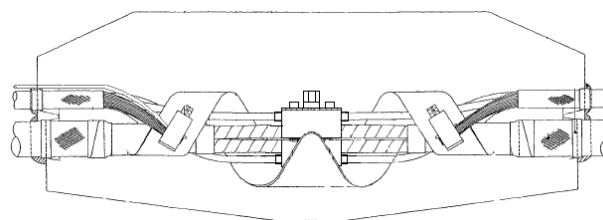
**95 Consac – 70mm Copper**

**150/185/240mm Consac – 120mm  
Copper**



2.15 Arrangements of the N/E connections in Service Joints.

On completion of the joint carefully re-wrap the aluminium sheath maintaining a clearance of 10mm **at all times**

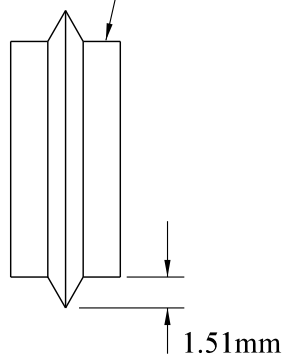




All dimensions in mm

### DEEP CUTTING WHEEL 1.51mm

Size Marked On Shoulder Of  
Wheel 1.51mm



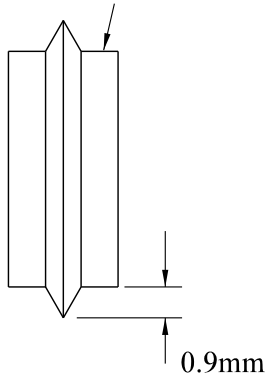
USE ON -

150mm<sup>2</sup> CONSAC  
185mm<sup>2</sup> CONSAC  
240mm<sup>2</sup> CONSAC

95mm<sup>2</sup> } 11kV C.A.S.  
185mm<sup>2</sup> } Or  
S.A.S.

### SHALLOW CUTTING WHEEL 0.9mm

Size Marked On Shoulder Of  
Wheel '0.9mm'



USE ON -

70mm<sup>2</sup> CONSAC  
95mm<sup>2</sup> CONSAC  
120mm<sup>2</sup> CONSAC

BEFORE USING SHEATH CUTTING TOOL CHECK THAT  
SIZE OF WHEEL IS CORRECT

1	RJB			01/13	EXTRA CABLE SIZE ADDED
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			CUTTING WHEEL		
			Rev No		
			1		

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## **GENERAL REQUIREMENT 13**

### **OPENING LEAD SHEATHS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

For safety and the controlled removal of lead sheaths the tramlining method and metallic knives will no longer be used on live cables.

#### **1. Removing Lead Sheaths - Sheaths with an outside diameter of less than 40mm.**

- A. Apply an approved earth continuity bond.
- B. Apply 3 turns of 16 gauge tinned copper wire at the two termination positions

Cut the lead sheath length-wise between the two binders using an approved insulated hack knife and hammer. A metal hack knife shall not be used. Care must be exercised to ensure that the belt papers are not damaged.

- C. Lift the lead using hand pressure or with the assistance of an approved insulated wedge and tear the lead against the binder.
- D. Once the lead has been removed an approved insulated belling tool can be used to slightly bell the mouth the lead sheath (if the bell mouth is not formed during the tearing operation). Care being taken so as not to damage the belt papers with the belling tool.

#### **2. Removing Lead Sheaths - Sheaths with an outside diameter of 40mm or more.**

- A. Apply an earth continuity bond.
- B. Make a circumferential score using an approved insulated ceramic knife (do not score more than half way through the lead)

Cut the lead sheath length-wise between the two binders using an approved insulated hack knife and hammer. A metal hack knife shall not be used. Care must be exercised to ensure that the belt papers are not damaged.

- C. Lift the lead using hand pressure or with the assistance of an approved insulated wedge and tear the lead against the binder.
- D. Once the lead has been removed an approved insulated belling tool can be used to slightly bell the mouth the lead sheath (if the bell mouth is not formed during the tearing operation). Care being taken so as not to damage the belt papers with the belling tool.

## **GENERAL REQUIREMENT 14**

### **OPENING AND CUTTING WAVECON 3 AND 4 CORE CABLE**

Before commencing the opening and cutting of the Wavecon cable, the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

ALL cables must be assumed live until proved dead in accordance with GR2.

#### **Attention is drawn to the following: -**

General Requirement 3 “General Jointing Procedures and Safety Precautions – Live Cables”

General Requirement 20 “Temporary Earthing of Neutral/Earth Conductors in Live LV Cables During Jointing”.

The cutting of Wavecon Cables must be carried out as detailed below. The dimensions to be utilised are those given in the relevant Jointing Procedure for the joint to be made.

#### **14.1 3 Core Wavecon**

1. Remove the PVC oversheath as detailed in General Requirement 6.
2. Open the neutral/earth wires as detailed in General Requirement 8.
3. Remove the rubber bedding as detailed in General Requirement 9.
4. Shroud exposed neutral and metalwork for 300mm each side of the joint as detailed in General Requirement 21.
5. Using an approved insulated wedge splay one core at the centre of the joint approximately 25mm.
6. Using an approved insulated bell punch carefully expose a small area of the core at the position it is to be cut.
7. Use a test lamp to ascertain if the phase is alive or dead.

**If the phase is not live when expected to be live or not dead when expected to be dead the supervisor must be informed before jointing work continues.**

**The test lamp must be proved before and after use.**

8. Using approved insulated core croppers or an approved insulated junior hacksaw, cut the core at the required position. Care must be exercised when cutting the core to ensure that other core(s) are not damaged otherwise a flashover may occur. When a core is being cut with a hacksaw or croppers the other cores must be shielded at the cutting position by an approved insulated core guard wedge.
9. Using a test lamp check to ensure the cut core is live from either one or both ends. The test lamp should be connected between neutral/earth and the cut ends of the core.

If either end of the cut core is dead (not as expected) the Supervisor should be informed.

10. Insulate both ends of the cut core, using adhesive backed rubber patches. Wrap the patch around the core, overlapping the end and pinch edges together. Trim as shown in Drawing GRD 6.14.1. The patches should not be re-used and should be disposed of, after use.
11. Repeat operation 6 to 10 on the remaining phase cores, taking each core in turn.

**Only one core must be exposed at a time.**

12. When all cores have been cut and insulated, remove the shrouding from the neutral/earth wires and other metalwork. Apply a temporary earth to the neutral/earth wires before cutting as detailed in General Requirement 20. The neutral/earth wires are to be cut at a position appropriate to the joint to be made.

#### **14.2 4 Core Wavecon**

1. Remove the PVC oversheath as detailed in General Requirement 6.
2. Open the earth wires as detailed in General Requirement 8.
3. Remove the rubber bedding as detailed in General Requirement 9.
4. Shroud exposed neutral and metalwork for 300mm each side of the joint as detailed in General Requirement 21.
5. Using an approved insulated wedge splay one core at the centre of the joint approximately 25mm.
6. Using an approved insulated bell punch carefully expose a small area of the core at the position it is to be cut.

7. Use a test lamp to ascertain if the phase is alive or dead.

**If the phase is not live when expected to be live or not dead when expected to be dead the supervisor must be informed before jointing work continues.**

**It is essential that the core to be cut is identified as a phase core as the neutral core must be cut last.**

**The test lamp must be proved before and after use.**

8. Using approved insulated core croppers or an approved insulated junior hacksaw, cut the core at the required position. Care must be exercised when cutting the core to ensure that other core(s) are not damaged otherwise a flashover may occur. When a core is being cut with a hacksaw or croppers the other cores must be shielded at the cutting position by an approved insulated core guard wedge.
9. Using a test lamp check to ensure the cut core is live from either on or both ends. The test lamp should be connected between the earth wires and the cut ends of the core.

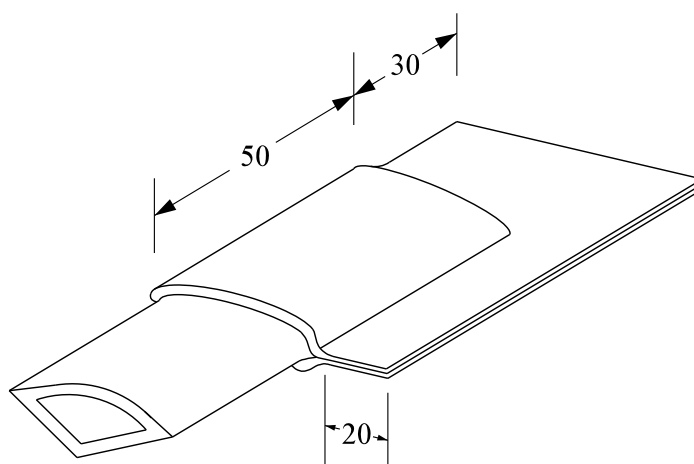
**If either end of the cut core is dead (not as expected) the Supervisor should be informed.**


10. Insulate both ends of the cut core, using adhesive backed rubber patches. Wrap the patch around the core, overlapping the end and pinch edges together. Trim as shown in Drawing GRD 6.14.1. The patches should not be re-used and should be disposed of, after use.
11. Repeat operations 6 to 10 on the remaining phase cores, taking each core in turn.

**Only one core must be exposed at a time and the neutral core must be cut last.**

12. When all phase cores have been cut and insulated, cut and insulate the neutral, remove the shrouding from the earth wires and other metalwork. The earth wires are to be cut at a position appropriate to the joint to be made.

All dimensions in mm



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				Title	
				OPENING AND CUTTING THREE AND FOUR CORE WAVECON CABLES CORE INSULATION PATCH DIMENSIONS	
				Drg. No. GRD 6.14.1	
				Rev No	

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## **GENERAL REQUIREMENT 15**

### **OPENING AND CUTTING CONSAC CABLES**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

ALL cables must be assumed to be live unless proved dead in accordance with GR2

#### **Attention is drawn to the following: -**

General Requirement 3 “General Jointing Procedures and Safety Precautions – Live Cables”

General Requirement 20 “Temporary Earthing of Neutral/Earth Conductors in Live LV Cables during Jointing”

The cutting of Consac cables must be carried out as detailed below. The dimensions to be utilised are those given in the relevant Jointing Procedure for the joint to be made.

1. Remove the PVC oversheath from the cable as detailed in General Requirement 6.
2. Open the aluminium neutral sheath as detailed in General Requirement 12.
3. Reduce the width of the horizontal portion of the aluminium sheath as detailed in General Requirement 12.
4. Shroud Exposed Neutral and Metalwork for 300mm either side of the joint as detailed in General Requirement 21.
5. Tie off the belt papers each end of the joint with hemp string or secure with Scotch 70 tape. Remove the belt papers by unwrapping and tearing off against the tie or cut the papers using a ceramic knife.
6. Using an approved insulated wedge splay one core at the centre of the joint approximately 25mm.
7. Tie of the core papers with hemp string binder or secure with Scotch 70 tape 5mm either side of the position at which the splayed core is to cut, this being determined by the joint to be made.
8. Using an approved insulated bell punch carefully expose a small area of the core at the position it is to be cut.

9. Use a test lamp connected between the exposed phase and neutral to ascertain if the phase is live or dead.

**If the phase is not live when it is expected to be live or not dead when expected to be dead the Supervisor must be informed before jointing work continues.**

**The test lamp must be proved before and after use.**

10. Using core approved insulated croppers or an approved insulated junior hacksaw cut the core at the required position. Care must be exercised when cutting the core to ensure that the other core(s) are not damaged or a flashover may occur. When a core is being cut with a hacksaw or croppers the other core(s) must be shielded at the cutting position by an approved insulated core guard wedge.
11. Using a test lamp check to ensure the cut core is live from either one or both ends. The test lamp should be connected between the neutral/earth sheath and cut ends of the core.

**If either end of the cut core is dead (not as expected), the Supervisor should be informed.**

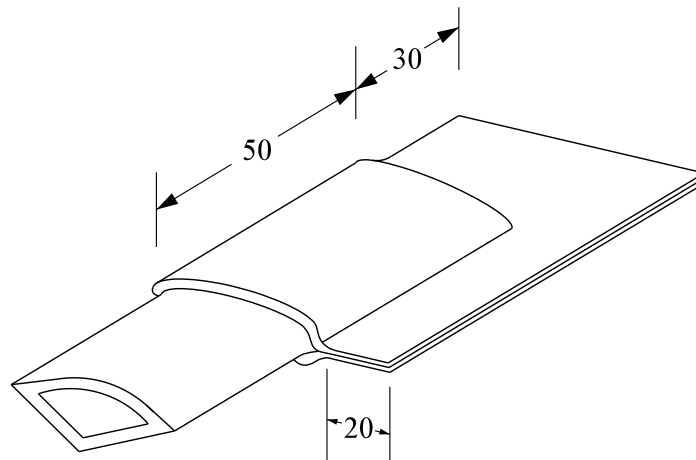
12. Insulate both ends of the cut core, using adhesive backed rubber patches. Wrap the patch around the core, overlapping the end and pinch edges together. Trim as shown in Drawing GRD 6.15.1. The patches should not be re-used and should be disposed of, after use.
13. Repeat operations 8 to 12 on the remaining phase cores, taking each core in turn.


**Only one core must be exposed at a time.**

14. When all cores have been cut and insulated, remove the shrouding from the neutral/earth sheath and other metalwork. Apply a temporary earth to the neutral/earth sheath before cutting as detailed in General Requirement 20. The neutral/earth sheath is to be cut a position appropriate to the joint to be made.



All dimensions in mm



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Checked				<div>Title    OPENING AND CUTTING CONSAC CABLES CORE INSULATION PATCH DIMENSIONS</div> <div>Drg. No. GRD 6.15.1</div> <div>Rev No</div>	
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## **GENERAL REQUIREMENT 16**

### **OPENING AND CUTTING PILC LOW VOLTAGE CABLES**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

ALL cables must be assumed to be live unless proved dead in accordance with GR2

#### **Attention is drawn to the following:-**

General Requirement 3 “General Jointing Procedures and Safety Precautions – Live Cables”.

The cutting of paper/lead cables must be carried out as detailed below. The dimensions to be utilised are those given in the relevant Jointing Procedure for the joint to be made.

1. Remove the outer serving as detailed in General Requirement 10.
2. Remove the armour tape as detailed in General Requirement 10.
3. Remove the bedding tapes and clean the lead sheath thoroughly as detailed in General Requirement 10.
4. Place an approved temporary continuity bond across the joint area as detailed in General Requirement 11.
5. Mark the lead sheath appropriate to the joint to be made and remove the lead sheath as detailed in General Requirement 13.
6. Shroud all earthed metalwork on all sides of the joint with approved insulated sheeting for a distance of at least 300mm including continuity bond and ends of lead sheath as detailed in General Requirement 21.
7. Tie off the belt papers approximately 20mm from each end of the joint with hemp string or secure with Scotch 70 tape. Remove the belt papers by unwrapping and tearing off against the tie or cut the papers using an approved insulated ceramic knife.
8. Carefully ease out each filler using an approved insulated wedge and cut off, outwards, close to the ends of the belt papers.
9. Using an approved insulated wedge splay one phase core at the centre of the joint.
10. Tie off the core papers with a hemp string binder or secure with Scotch 70 tape 5mm either side of the position at which the splayed core is to be cut, this being determined by the joint to be made.

11. Using an approved insulated bell punch carefully expose a small area of the core at the position where it is to be cut.
12. Use a test lamp connected between the exposed phase core and the lead sheath to check whether the core is live or dead.

**If the phase is not live when it is expected to be live or not dead when expected to be dead the Supervisor must be informed before jointing work is continued.**

**It is essential that the core to be cut is identified as a phase core as the neutral core must be cut last.**

**The test lamp must be tested before and after use.**

13. Using core approved insulated croppers or an approved insulated junior hacksaw cut the core at the required position. Care must be exercised when cutting the core to ensure that the other core(s) are not damaged otherwise a flashover may occur. When a core is being cut with a hacksaw or croppers the other cores must be shielded at the cutting position by a core guard wedge.
14. Using a test lamp check to ensure the cut core is live from either one or both ends. The test lamp should be connected between the lead sheath and cut ends of the core.

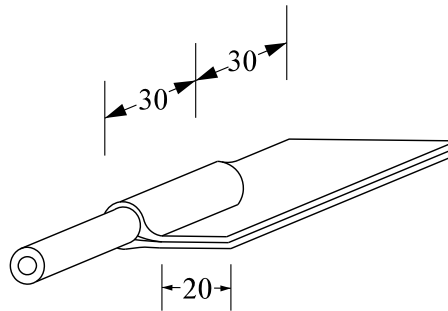
**If either end of the cut core is dead (not as expected) the Supervisor should be informed.**

15. Insulate both ends of the cut core, using adhesive backed rubber patches. Wrap the patch around the core, overlapping the end and pinch edges together. Trim as shown in Drawing GRD 6.16.1. The patches should not be re-used and should be disposed of, after use.
16. Repeat operations 9 to 15 on the remaining phase cores, taking each core in turn.

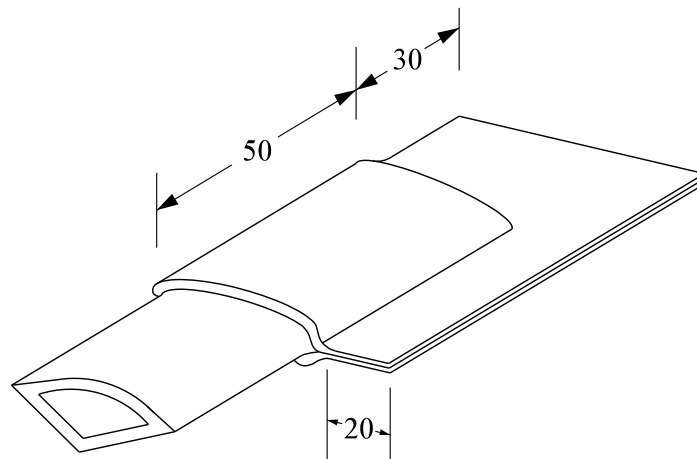
**Only one core must be exposed at a time and the neutral core must be cut last.**

17. When all phase cores have been cut and insulated, cut and insulate the neutral, remove the shrouding and earth continuity bond from the lead sheath and other metal work.

All dimensions in mm



Cables Up To And Including 35mm<sup>2</sup>



Cables Above 35mm<sup>2</sup>

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Approved					
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## GENERAL REQUIREMENT 17

### OPENING AND CUTTING PVC CONCENTRIC SERVICE CABLES

Before commencing the level of PPE required for the operation shall be as the matrix given in General Requirement 3.

#### Attention is drawn to the following: -

General Requirement 3 - “General Jointing Procedures and Safety Precautions – Live Cables”.

**Note: -** This technique is applicable only when it is impossible to spring the phase core(s) from under the concentric neutral and earth wires in order to cut it/them before cutting the neutral/earth.

The procedures are illustrated in Drawing GRD 6.17.1 (plain concentric cables) and Drawings GRD 6.17.2 /6.17.3 (split-concentric cables).

The cutting of PVC service cables must be carried as detailed below. The dimensions to be utilised are those given in the relevant Jointing Procedure for the joint to be made.

#### 17.1 Plain concentric cables: - Drawing GRD 7.17.1, 6.17.4

1. Ensure that the cable is straight and supported. Check also that the cable is undamaged.
2. Mark the centre line and the PVC oversheath cut positions. The dimensions are given in Drawing GRD 6.17.4 and GRD 6.17.1 – Fig 1.
3. Remove the PVC oversheath between the marks as detailed in General Requirement 6 – Fig 2.
4. Remove any bedding tape (if present).
5. Remark the centre line.
6. Cut **half** the neutral/earth wires 50mm beyond the centre line towards the side to be abandoned.

For the number of wires to be cut, see Drawing GRD 6.17.4.

Lift the wires, a few at a time, using a small approved insulated wedge and cut with side-cutting pliers.

7. Form the cut wires into a conductor without twisting.
8. Connect across cut wires using the temporary bridge – Fig 3. (Details of temporary bridge are shown in GRD 6.17.5).

9. Cut the remaining neutral/earth wires and place alongside the wires cut in 6 – Fig 4.
10. Shroud the neutral/earth wires and all other earthed metalwork for at least 300mm from the joint – Fig 4.
11. Use an approved insulated bell punch carefully expose a small area of the core at the position where it is to be cut. Alternatively a core knife may be used to cut a small vee on smaller diameter cores.
12. Use a test lamp connected between the exposed core and the neutral/earth wires to check whether the core is live or dead.

**If the phase is not live when it is expected to be live or not dead when expected to be dead the Supervisor must be informed before jointing work continues.**

**The test lamp must be proved before and after use.**

13. Using approved insulated core croppers or approved insulated junior hacksaw, cut the core at the required position. Care must be exercised when cutting the core to ensure that the other core(s) are not damaged otherwise a flashover may occur. When a core is being cut with a hacksaw or croppers the other cores must be shielded at the cutting position by a core guard wedge.
14. Using a test lamp check to ensure the cut core is live from either one or both ends. The test lamp should be connected between the lead sheath and cut ends of the core.

If either end of the cut core is dead (not as expected) the Supervisor should be informed.

15. Insulate both ends of the cut core, using adhesive backed rubber patches. Wrap the patch around the core, overlapping the end and pinch edges together. Trim as shown in Drawing GRD 6.17.6. The patches should not be re-used and should be disposed of, after use.
16. If the cable is three phase repeat operations 11-15 on the remaining phase cores, taking each core in turn.

**Only one core must be exposed at a time.**

17. When all cores have been cut and insulated remove the shrouding and the temporary bridge.

## **17.2 Split Concentric Cables – Drawing 6.17.2/6.17.3**

1. Ensure the cable is straight and supported. Check also that the cable is undamaged.
2. Mark the centre line and the PVC oversheath cut positions. The dimensions are given in Drawing GRD 6.17.4 and GRD 6.17.2.3 – Fig 1.

3. Remove the PVC oversheath between the marks as detailed in General Requirement 6 – Fig 2.
4. Remove any bedding tape (if present).
5. Remark the centre line.
6. Cut **half** of the earth wires 50mm beyond the centre line towards the side to be abandoned – Fig 3.

For the number of wires to be cut, see Drawing GRD 6.17.4.

Lift the wires, a few at a time, using a small approved insulated wedge and cut with side-cutting pliers.

7. Form the cut earth wires into a conductor without twisting – Fig 3.
8. Connect across the cut earth wires using a temporary bridge. (Details of temporary bridge are shown in GRD 6.17.5).
9. Cut the remaining earth wires and place alongside the wires cut in 6(a) – Fig 3.
10. Shroud the earth wires – Fig 5.
11. Cut **half** of the neutral wires 50mm beyond the centre line towards the side to be abandoned – Fig 4.

For the number of wires to be cut, see Drawing GRD 6.17.4.

Lift the wires, a few at a time, using a small approved insulated wedge and cut with approved insulated side cutting pliers.

12. Form the cut neutral wires into a conductor without twisting.
13. Connect across the cut neutral wires using a temporary bridge – Fig 4.
14. Cut the remaining neutral wires and place alongside the wires cut in 11(a).
15. Shroud the neutral wires and any other earthed metalwork for at least 300mm from the joint – Fig 5.
16. Use an approved insulated bell punch to carefully expose a small area of the core at the position where it is to be cut. Alternatively an approved insulated ceramic knife may be used to cut a small vee on smaller diameter cores.

17. Use a test lamp connected between the exposed core and the neutral/earth wires to check whether the core is live or dead.

**If the phase is not live when it is expected to be live or not dead when expected to be dead the Supervisor must be informed before jointing work is continued.**

**The test lamp must be proved before and after use.**

18. Using approved insulated core croppers or an approved insulated junior hacksaw, cut the core at the required position. Care must be exercised when cutting the core to ensure that the other core(s) are not damaged otherwise a flashover may occur. When a core is being cut with a hacksaw the other cores must be shielded at the cutting position by an approved insulated core guard wedge.
19. Using a test lamp check to ensure the cut core is live from either one or both ends. The test lamp should be connected between the lead sheath and cut ends of the core.

**If either end of the cut core is dead (not as expected) the Supervisor should be informed.**

20. Insulate both ends of the cut core, using adhesive backed rubber patches. Wrap the patch around the core, overlapping the end and pinch edges together. Trim as shown in Drawing GRD 6.16.1. The patches should not be re-used and should be disposed of, after use.
21. If the cable is three phase repeat operations 16-20 on the remaining cores.

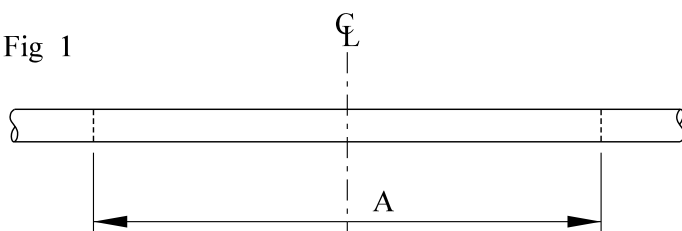
**Only one core must be exposed at a time.**

22. When all cores have been cut and insulated remove the shrouding and the temporary bridges.



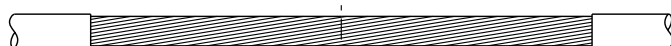
All dimensions in mm

Fig 1



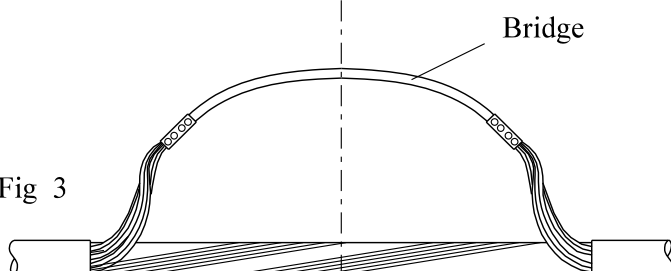
Mark Centre Line And  
PVC Sheath Cuts  
(For Dimension 'A' See  
Drg GRD 6.17.4)

Fig 2



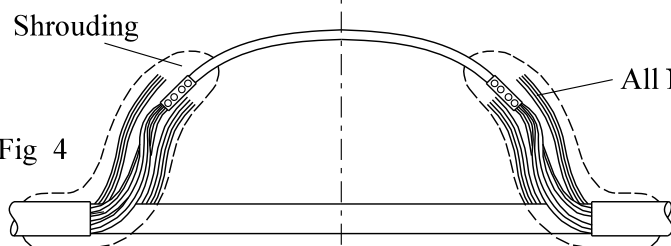
Remove PVC Oversheath

Fig 3



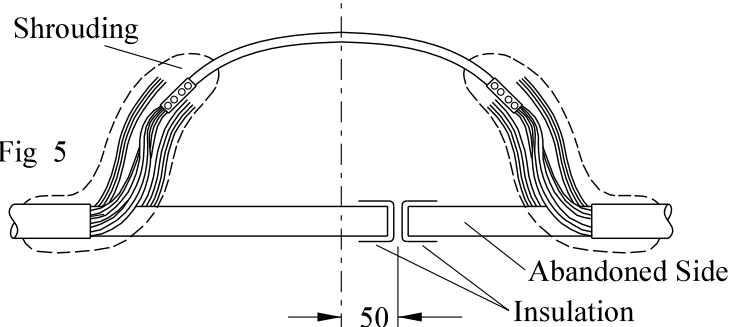
Cut Half The Neutral / Earth Wires  
(For Number See GRD 6.17.4)  
Connect Via Bridge

Fig 4




Cut Remaining Neutral / Earth  
Wires And Shroud

Fig 5

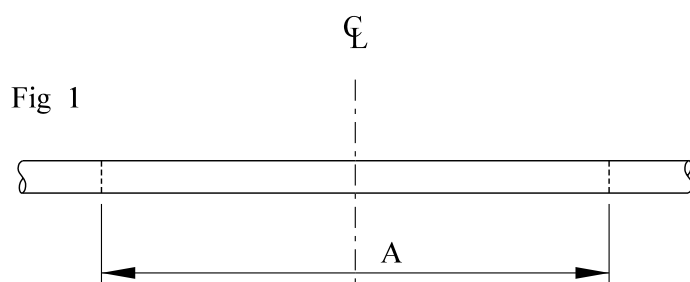


Cut Phase Core(s) And  
Insulate The Exposed Ends

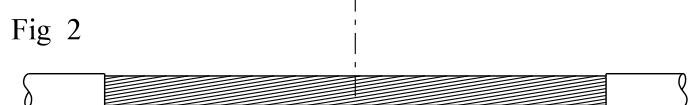
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Checked					
Approved					
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Title OPENING AND CUTTING PVC CONCENTRIC SERVICE CABLES - PLAIN CONCENTRIC					Drg. No. GRD 6.17.1 Rev No

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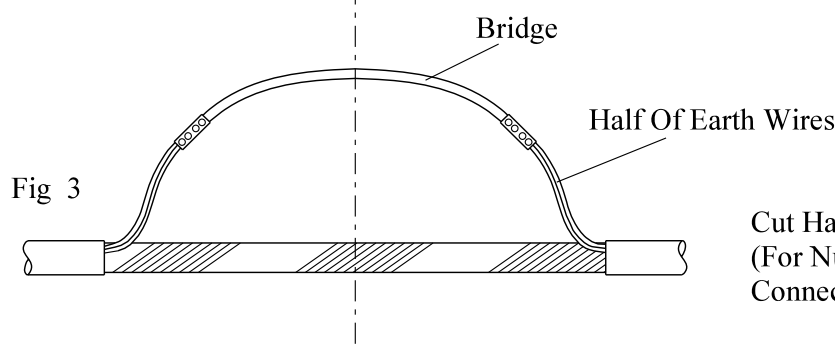
All dimensions in mm




Mark Centre Line And  
PVC Sheath Cuts  
(For Dimension 'A' See  
Drg GRD 6.17.4)



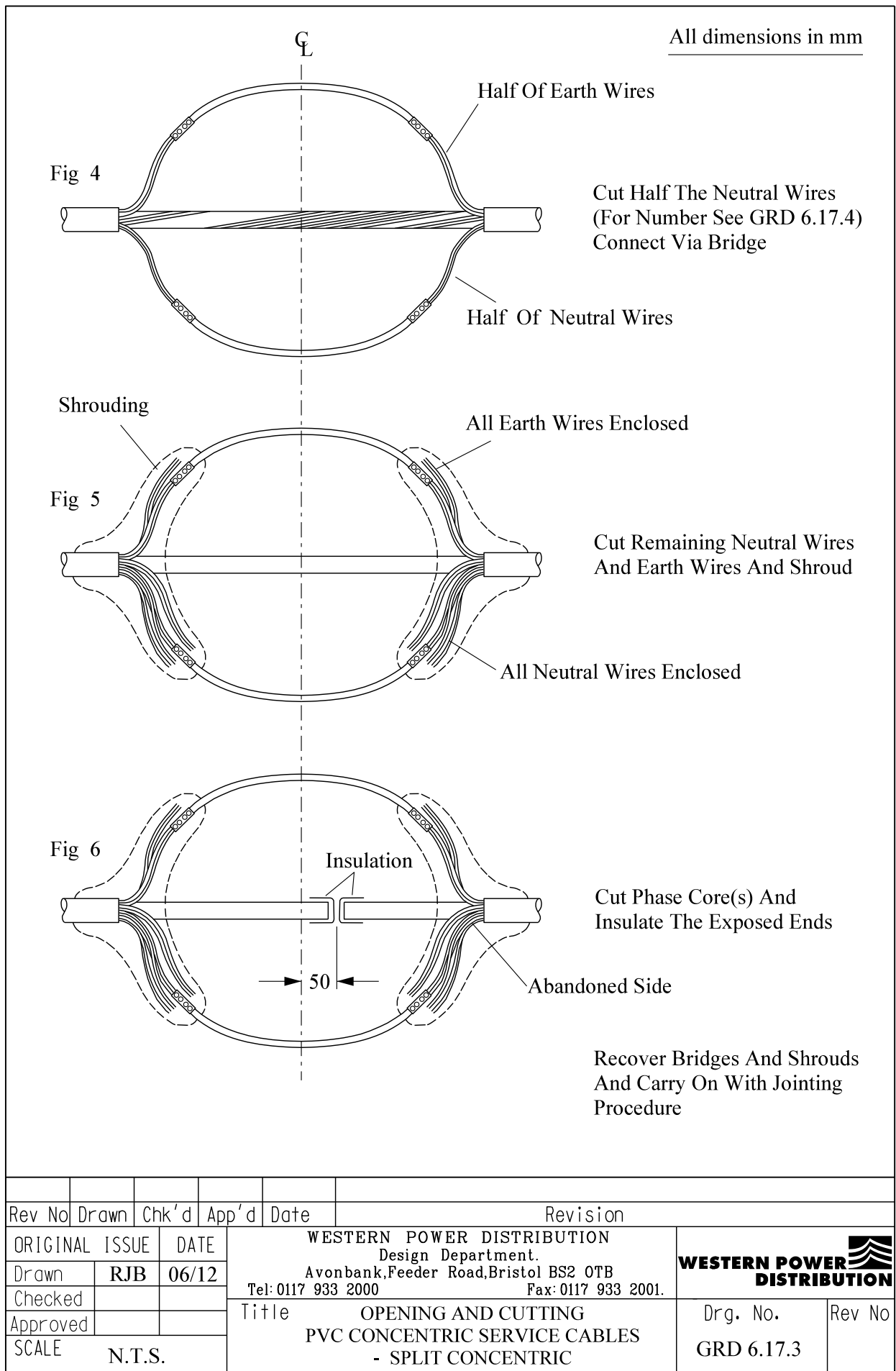
Remove PVC Oversheath



Cut Half The Earth Wires  
(For Number See GRD 6.17.4)  
Connect Via Bridge

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SCALE N.T.S.			Title <b>OPENING AND CUTTING PVC CONCENTRIC SERVICE CABLES - SPLIT CONCENTRIC</b>			Drg. No. <b>GRD 6.17.2</b> Rev No

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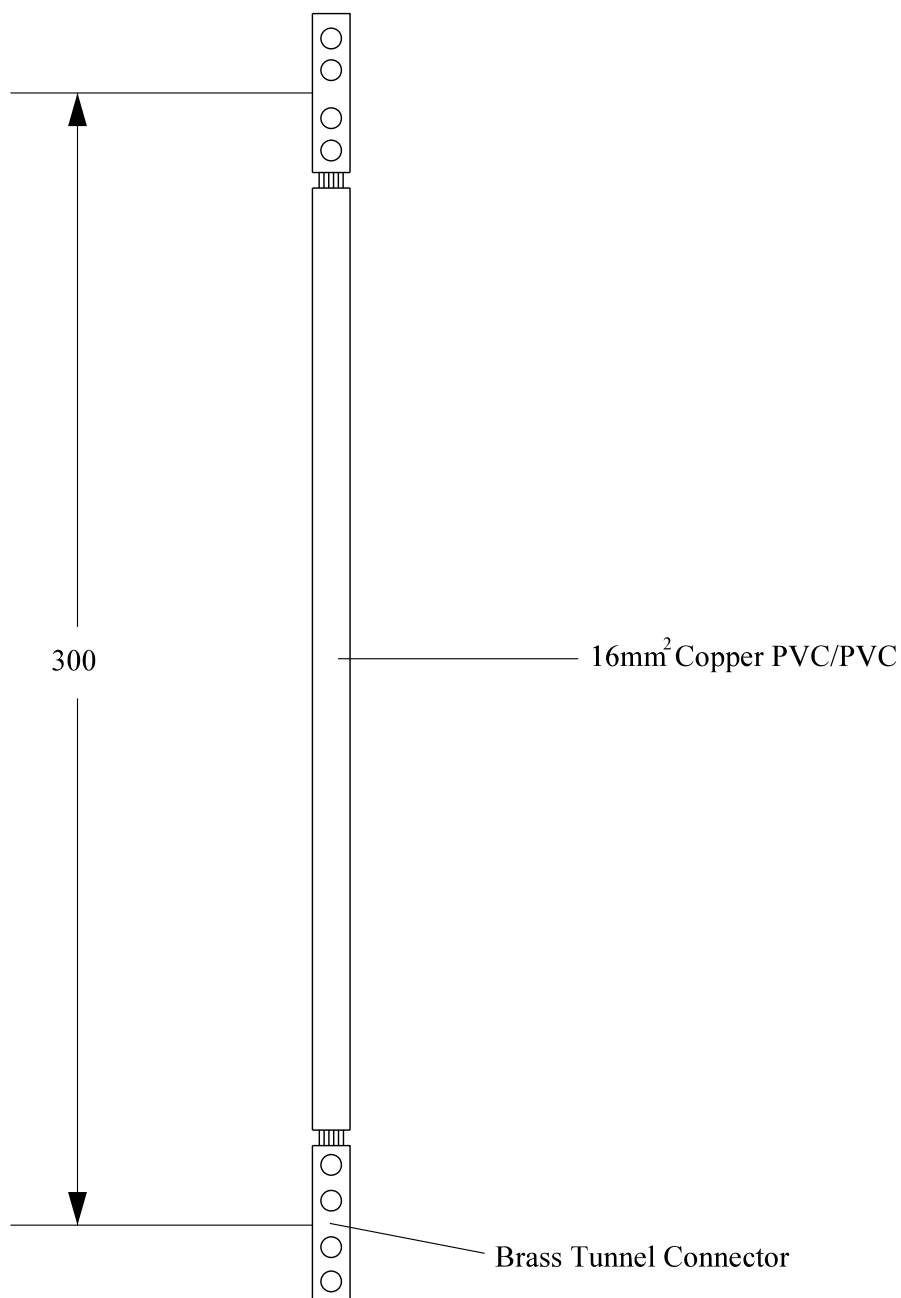
All dimensions in mm

CABLE SIZE AND TYPE	PVC CUT 'A'	NO: OF NEUTRAL / EARTH WIRES TO BE CUT	
SINGLE PHASE HYBRID 25	300	14	
SINGLE PHASE HYBRID 35	300	12	
THREE PHASE HYBRID 25	450	22	
THREE PHASE HYBRID 35	450	30	
SINGLE PHASE Cu CONC 4	300	7	
SINGLE PHASE Cu CONC 16	300	14	
SINGLE PHASE Cu CONC 25	300	12	
THREE PHASE Cu CONC 16	450	24	
THREE PHASE Cu CONC 25	450	28	
		NEUTRAL	EARTH
SINGLE PHASE SPLIT - CONC 4	300	4	2
SINGLE PHASE SPLIT - CONC 16	300	4	2
SINGLE PHASE SPLIT - CONC 25	300	6	2
THREE PHASE SPLIT - CONC 25 AL	450	15	5

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Drawn	RJB	06/12			
Checked				<div><div>Title</div><div>OPENING AND CUTTING PVC CONCENTRIC SERVICE CABLE - WIRE CUT TABLE</div></div>	
Approved					
SCALE		N.T.S.		<div><div>Drg. No.</div><div>GRD 6.17.4</div></div> <div>Rev No</div>	

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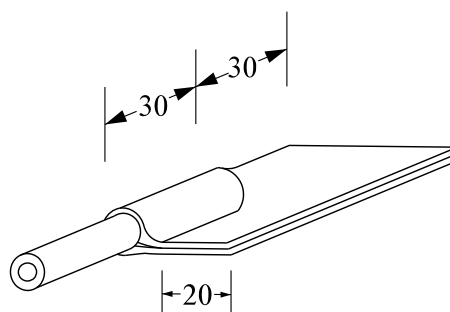
All dimensions in mm




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SCALE N.T.S.				Rev No	

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All dimensions in mm



Cables Up To And Including 35mm<sup>2</sup>

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## **GENERAL REQUIREMENT 18**

### **OPENING AND CUTTING PILC CONCENTRIC CABLES**

Due to the complex configuration and the associated hazards that may affect the individual and the system, opening and cutting of twin and triple PILC concentric cables is covered in a discreet document, ST: CA1U/1, 7.801 as a special requirement.

All information relating to the jointing of PILC concentric cables is to be found within this discrete Standard Technique.

## **GENERAL REQUIREMENT 19**

### **MOISTURE TESTING**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

Moisture if it penetrates into a cable will travel along the cable and may be detected many yards from the point of entry.

The moisture can travel along the belt papers, wormings, core papers or between the strands of the conductor. It is essential, therefore, when carrying out moisture tests that samples from each part of the cable are tested. The samples must not be touched by hand as the test is so sensitive that the moisture transferred from the hand to the sample will be detected.

#### **19.1 Safety Precautions**

##### **Skin Contact**

When the wax is in the molten state at elevated temperatures there is a risk of thermal burns, therefore contact with the skin should be avoided and precautions taken against accidental splashes. Skin sensitisation or irritation is very infrequent.

Molten wax on the skin should be cooled rapidly by cold water and removed carefully from the skin in not less than 30 minutes to avoid blistering, preferably under medical supervision to avoid tissue damage.

##### **Splashes in the Eye**

In the event of wax entering the eyes these should be flushed immediately with water for 15 minutes and medical attention obtained.

##### **Breathing of Vapour**

Paraffin wax poses virtually no hazard to health when used in normal industrial practice. There is no hazard from inhalation of the vapour nor is ingestion considered to be a normal industrial hazard. Wax fumes may cause eye and respiratory tract irritation if present in sufficiently high concentration, in such circumstances adequate ventilation is to be provided to prevent high concentration building up in the work area.

##### **Fire Hazard**

Although stable at the usage temperature paraffin wax may catch fire at temperatures above 175°C and in the event of a small fire, foam carbon dioxide, dry chemical powder, sand or earth may be employed to extinguish.

For larger fires where a high concentration of wax is stored use foam or water fog. Anyone tackling the fire must wear suitable respiratory equipment.



## **19.2 Testing Samples from a Cable**

The simple on-site method of testing cable papers using hot paraffin wax can be conveniently used for this purpose.

The paraffin wax is heated to a temperature of **140°C** and providing the wax shows no signs of frothing around the dipped items then the items can be assumed to be “dry”.

## **19.3 Method**

Heat the paraffin wax to the required temperature, monitoring the thermometer to keep the temperature constant throughout the test.

Take samples of the belt paper, outer and inner core papers, wormings and finally the core strands. These samples should be taken using dry knives and pliers.

The presence of moisture will be indicated by a foamy bubbling of the compound around the samples.

The samples should all be tested singly to avoid air trapped between layers causing bubbles in the compound.

Care must be taken to keep the compound temperature within the temperature range as higher temperatures will cause spurious bubbling and lower temperatures cannot be relied on to give an indication when moisture is present.

If the test shows moisture is present in the cable further tests should be made at 300mm intervals along the cable until it is proved dry in two consecutive tests.

**The Supervisor in charge of the work should be informed if moisture is found in a cable.**

## **GENERAL REQUIREMENT 20**

### **TEMPORARY EARTHING OF NEUTRAL/EARTH CONDUCTORS DURING JOINTING**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

It must be appreciated that when a live LV cable is cut a live stop end will be produced. It is essential that the neutral/earth is connected to earth on the live side of the cut position **before** being cut, to comply with the PME Regulations and to avoid danger to the Joiner and to consumers. If the cable is fed from both directions, then both sides of the cut position must be earthed.

These requirements may be complied with by adopting one or more of the following methods: -

1. A Hepworth temporary continuity device may be connected between metallic sheaths of Consac each side of the proposed cut position and left connected until the permanent connections to earth have been made.
2. An earth electrode and a 35 sq mm earthing lead connected to the neutral/earth wires of Wavecon.
3. Connecting the neutral/earth of the other cable to be jointed before the neutral/earth is cut.

**Where the jointing procedure involves the connection of the neutral/earth to a permanent earth this should be carried out in preference to the employment of a temporary earth.**

## **GENERAL REQUIREMENT 21**

### **TEMPORARY SHROUDING OF NEUTRALS, EARTHS AND OTHER EXPOSED METALWORK DURING JOINTING**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

General Requirement 3 states that, when jointing live, all exposed metalwork must be shrouded to a distance not less than 300mm on all sides of the joint.

The standard LV shrouding kit has various shapes and sizes for PILC, Consac and wavecon cables careful selection of the shrouding will ensure that any exposed neutral and or earth can be fully shrouded. As this is bespoke LV shrouding this is the preferred method of shrouding.

There are bespoke BCNE shrouds within the kits which fit over the BCNE connector and are temporarily held in place over the connector by a short length of Scotch 88 tape, once the joint has been complete the temporary shrouds are removed.

But in exceptional circumstances then the 1000 gauge polythene can be used to shroud, for example: -

It should be noted that when using 1000 gauge polythene to shroud the opened neutral of a Consac cable, it is possible to pierce the polythene with jointing tools, or to damage it by contact with the hot metal or gas torch. To prevent this happening, a piece of PVC oversheath from the Wavecon cable should be wrapped around the sheath over the polythene.

When shrouding Wavecon neutral/earths the clear sections of the wires should be encased with the new LV Shrouding, Co-flex and the remaining exposed portions such as connectors and the splayed wires should be wrapped with 1000 gauge polythene. PVC tape should be used to ensure that the various sections of shrouding are securely joined together.

## **GENERAL REQUIREMENT 22**

### **APPLICATION OF STEEL TAPE ARMOUR BOND**

Before commencing the level of PPE required for this operation shall be as the matrix given General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

When jointing on PILC mains or service cables the armour and lead sheaths must be bonded to prevent potential difference across the two.

This is undertaken using cold mechanical clamping methods, and is provided by two earth bond kits: -

Kit LVEB-08 for mains cables 50mm<sup>2</sup> (.06in<sup>2</sup>) – 300mm<sup>2</sup> (.5in<sup>2</sup>)

Kit LVSB-18 for service cables 4mm<sup>2</sup> (.007in<sup>2</sup>) – 35mm<sup>2</sup> (.05in<sup>2</sup>)

Each kit contains the materials for bonding the armour and bonding the lead sheath to the earth continuity conductor it also contains the mastic water blocking tape.

#### **22.1 Bonding of Steel Tape Armour – Drawing GRD 6.22.1, 6.22.2, 6.22.3**

1. Remove the outer serving (hessian) and armour to the dimensions shown in Drawing GRD 6.22.1 – Fig 1 and the relevant Jointing Procedure.
2. Remove the bitumen impregnated bedding from the lead sheath and thoroughly clean with an approved degreaser.
3. Abrade the lead sheath circumferentially 120mm from the armour termination and clean with an approved solvent – Fig 1.
4. Fold the tinned copper mesh along its length there by reducing its width by half and wrap equally around the lead sheath and armour – Fig 2.
5. Lay the tinned copper strip onto the armour side and secure with a worm drive clip – Fig 3.

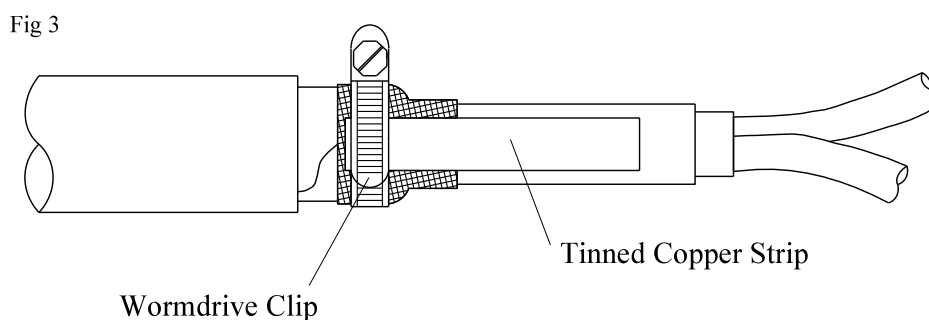
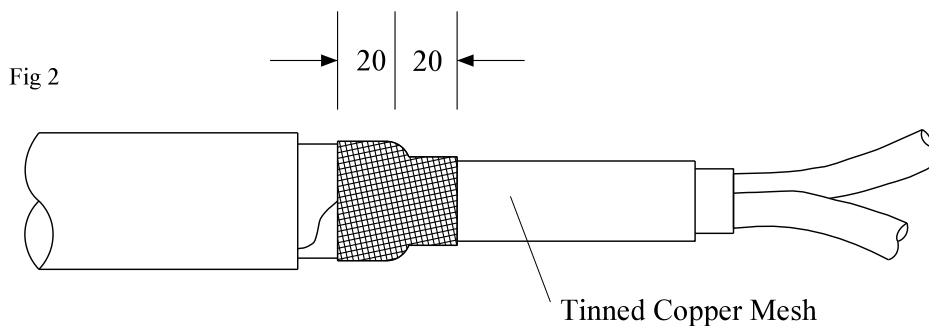
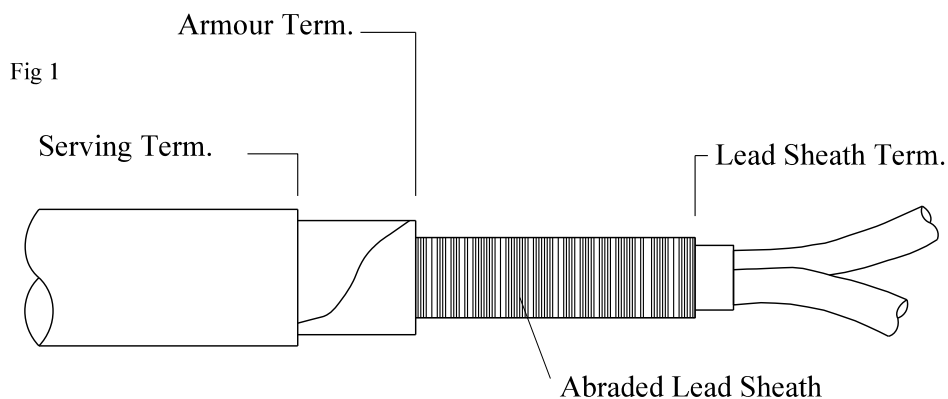
**Tighten with an approved Torque Driver Set at 5Nm.**

6. Bend the tinned copper strip to form a 90° bend to the cable and gently dress down onto the lead sheath. Wrap the tinned copper strip over the tinned copper mesh around the lead sheath – Fig 4-5.
7. Apply a worm drive clip over the tinned copper strip around the lead sheath – Fig 6.

**Tighten with a Torque Driver Set at 5Nm.**

8. Apply 2 half lapped layers of “88” black PVC tape covering the bare armour and extending to the end of the outer shell.

All dimensions in mm



PLAN VIEW

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Fig 4

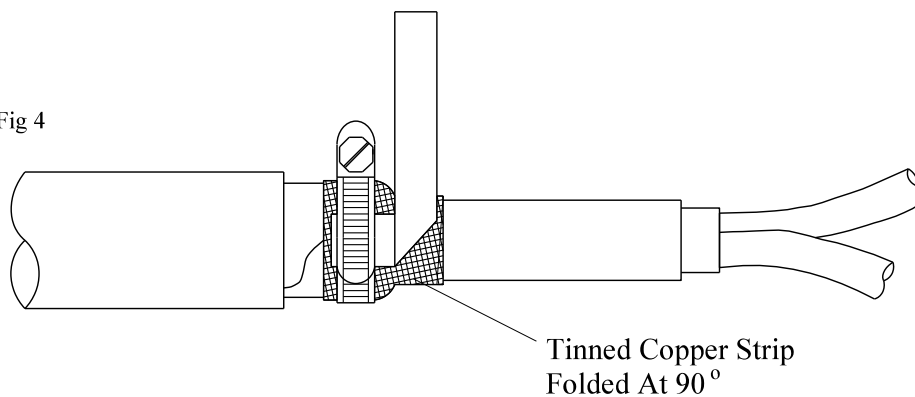


Fig 5

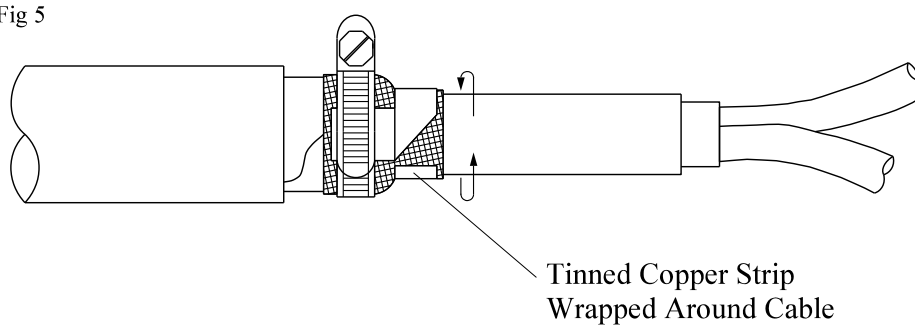
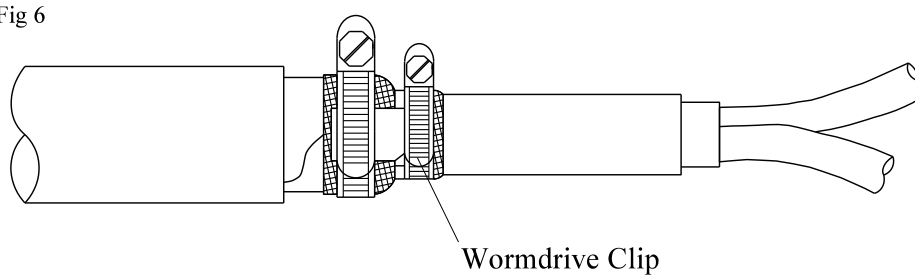



Fig 6

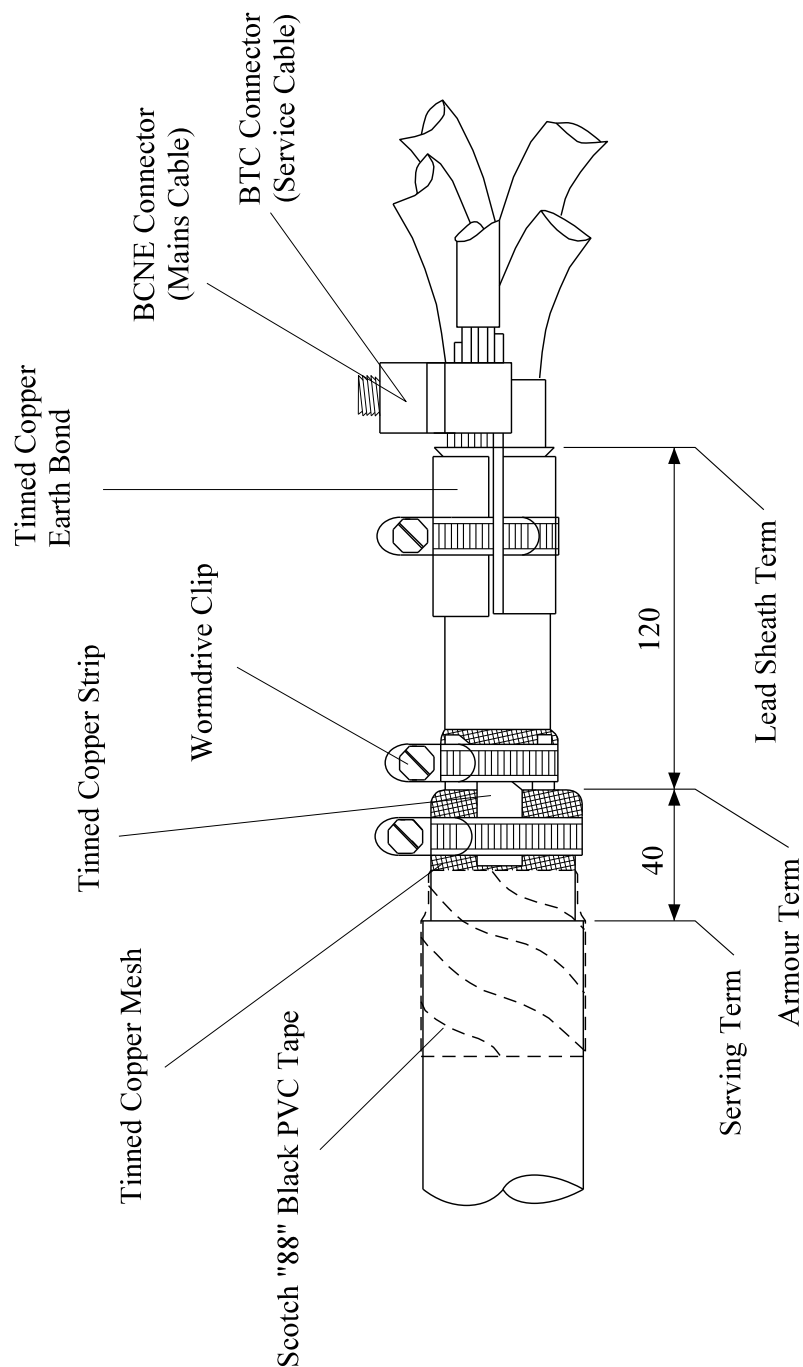


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SCALE	N.T.S.		Title <b>APPLICATION OF STEEL TAPE ARMOUR BOND</b>			Drg. No. <b>GRD 6.22.2</b> Rev No

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				ARMOUR BOND STRIPPING DIMENSIONS		GRD 6.22.3	
				/ GENERAL LAYOUT			

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## GENERAL REQUIREMENT 23

### APPLICATION OF LEAD SHEATH BOND

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

When jointing on PILC mains or service cables the lead sheaths are to be connected to provide continuity of the earth conductor (N/E where PME) across the joint and through the LV distribution system.

This is undertaken using cold mechanical clamping methods, and is provided by two earth bond kits:-

Kit LVEB-08 for mains cables  $50\text{mm}^2$  (.06in<sup>2</sup>) –  $300\text{mm}^2$  (.5in<sup>2</sup>)

Kit LVSB-18 for service cables  $4\text{mm}^2$  (.007in<sup>2</sup>) –  $35\text{mm}^2$  (.05in<sup>2</sup>)

Each kit contains the materials for bonding the armour and bonding the lead sheath to the earth continuity conductor, it also contains the mastic water blocking tape.

For PILC service cable cut-out changing a roll spring assembly is used, this method is **only approved** for this one Jointing Procedure on the LV distribution system.

#### 23.1 Lead Sheath Earth Bond – Drawing GRD 6.23.1, GRD 6.23.2, GRD 6.23.3

1. Ensure the lead sheath is thoroughly abraded and cleaned with an approved degreaser.
2. Wrap the paper template around the circumference of the lead sheath and place a mark 5mm less than the overlap to obtain the diameter -5mm. Fold the paper in half to this mark– Fig 1.
3. Place the template onto the tinned copper earth bond aligning the fold with the centre of the strip. Cut the strip to the required length – Fig 2.
4. Bend and shape the tinned copper earth bond smoothly around the lead sheath – Fig 3.
5. Apply a worm drive clip through the slot in and around the tinned copper earth bond strip – Fig 4/5.

**Tighten and shear the outer shear head bolt. When the joint is complete shear off the second shear bolt**

6. Using the BCNE or BTC connector, connect the earth conductor and where required any service earths and the copper earth tail to the tinned copper earth bond as and when detailed in the relevant Jointing Procedure – Drawings GRD 6.23.1, GRD 6.23.2 and GRD 6.23.3.



Fig 1.

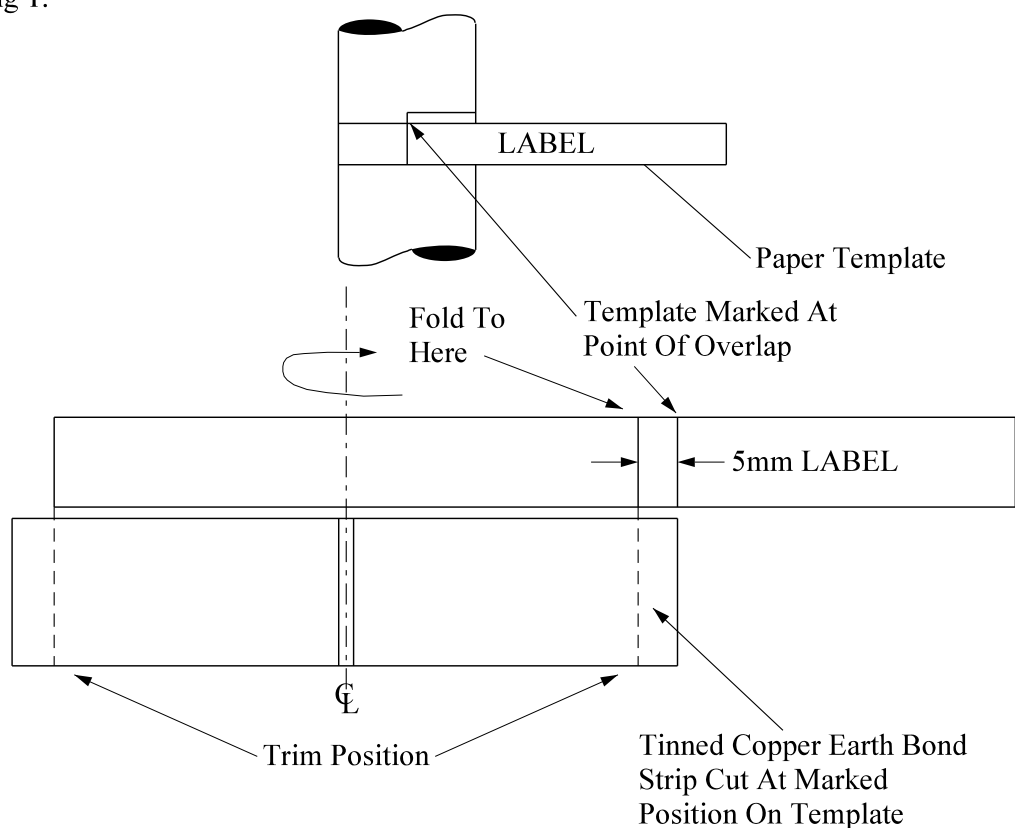
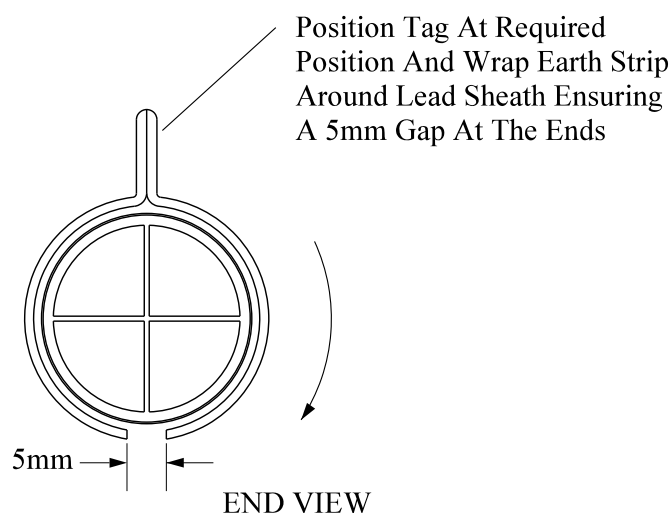



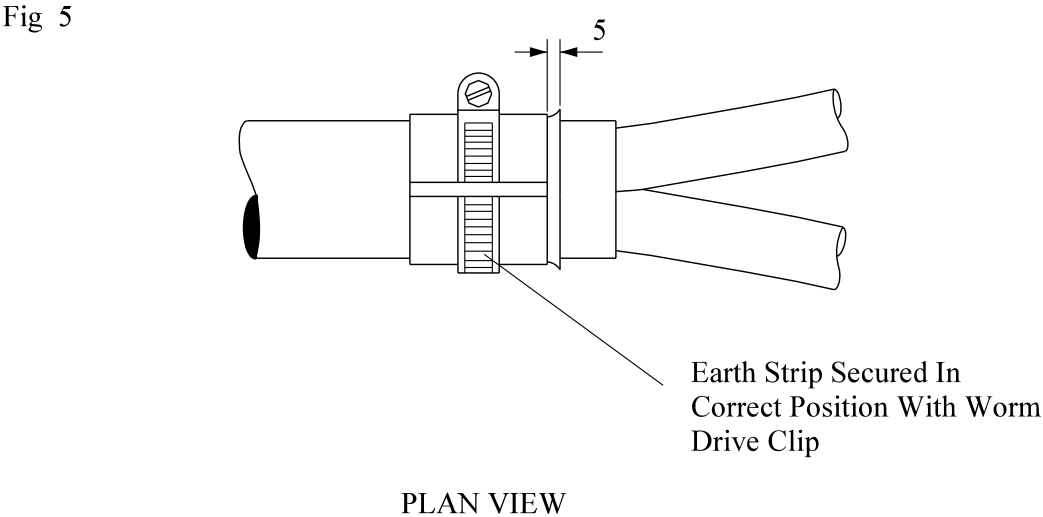
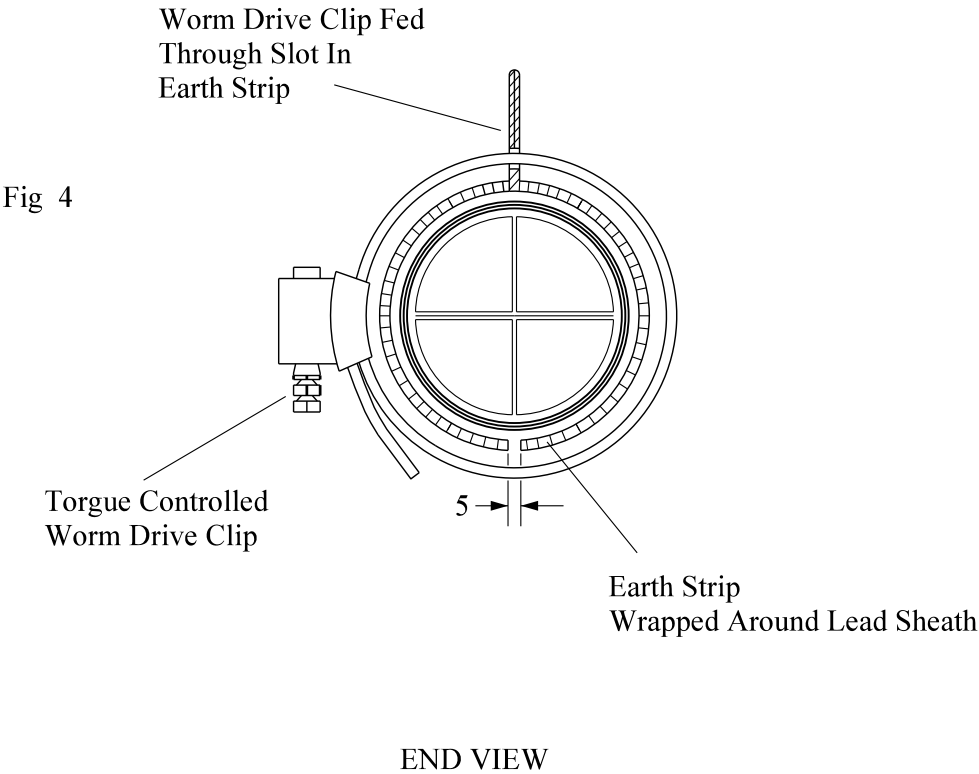
Fig 3.




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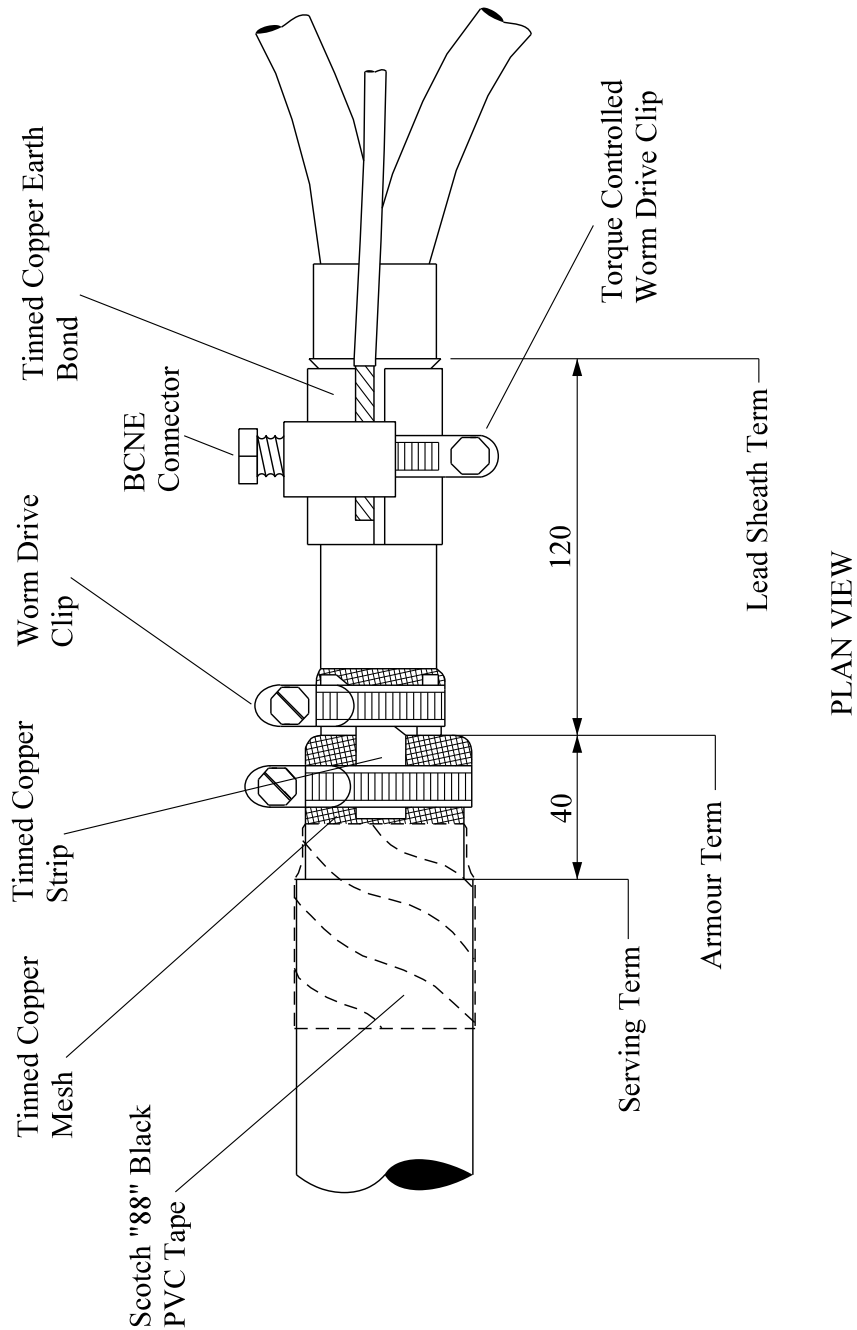
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## **23.2 Lead Sheath Earth Bond and Roll Spring – Drawing GRD 6.23.4, GRD 6.23.5**

**CAUTION – Roll springs may have sharp edges and where possible gloves are to be worn.**

**For electrical and mechanical stability the roll spring assembly must be assembled in the following sequence.**

1. Ensure lead sheath is thoroughly abraded and cleaned with an approved solvent – Fig 1.
2. Wrap a length of tinned copper mesh around the lead sheath – Fig 2.
3. Lay the earth braid directly onto the tinned copper mesh ensuring there is sufficient tail to allow the braid to be turned back over the roll spring – Fig 3.
4. Starting the roll spring opposite the earth braid apply one complete turn **over** the earth braid and wrapped in the same direction as the tinned copper mesh – Fig 4.
5. Turn the earth braid tail back over the roll spring and gently dress down to flatten – Fig 5.
6. Apply the remaining turns of the roll spring, tighten by hand using a twisting action – Fig 6.
7. Cover the complete assembly using ‘88’ black PVC tape with a minimum of three layers – Fig 7.

**This method of earthing is only approved for PILC cut-out changing.**

All dimensions in mm

NOTE:- For Electrical And Mechanical Stability.

The Roll Spring Assembly Must Be Assembled In The Following Sequence.

Fig 1

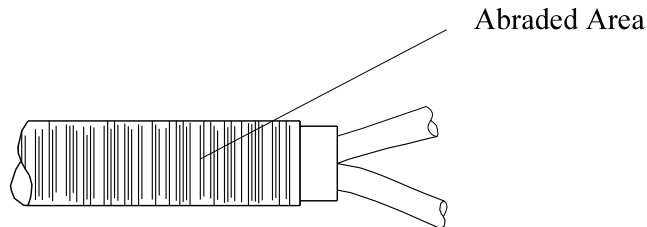


Fig 2

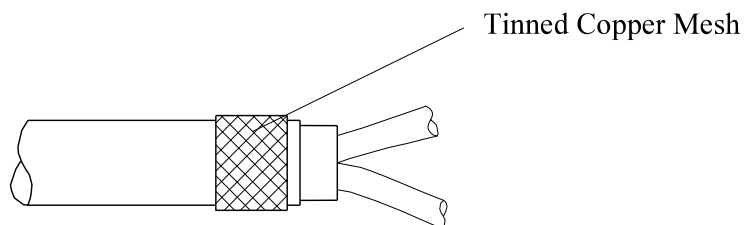


Fig 3

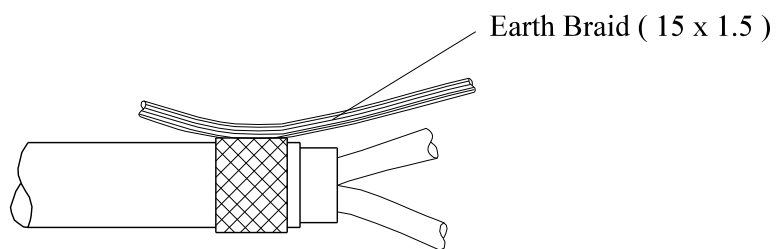
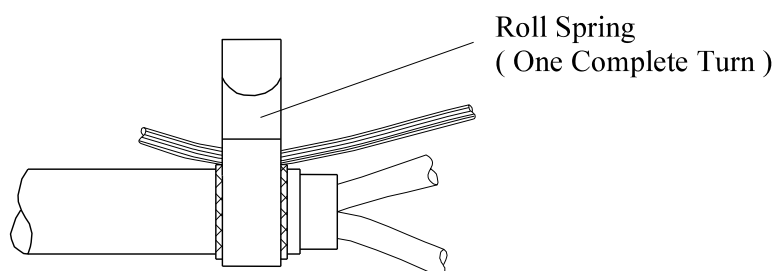


Fig 4



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Fig 5

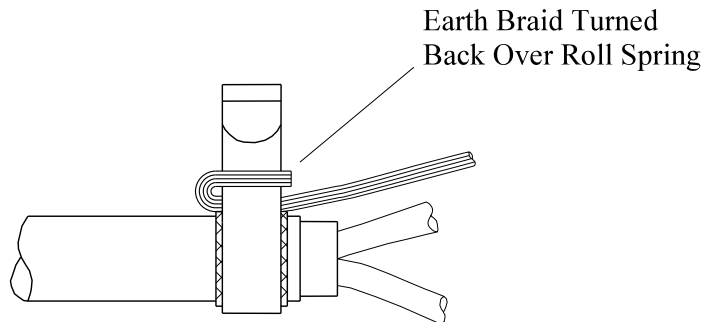


Fig 6

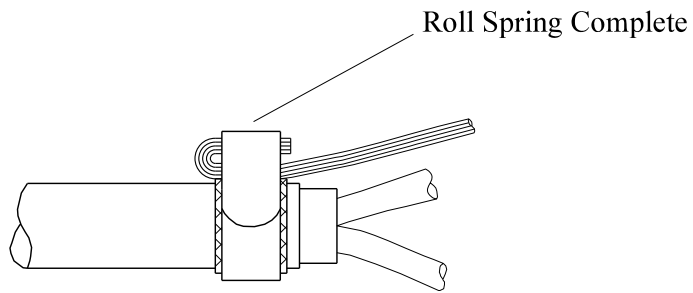
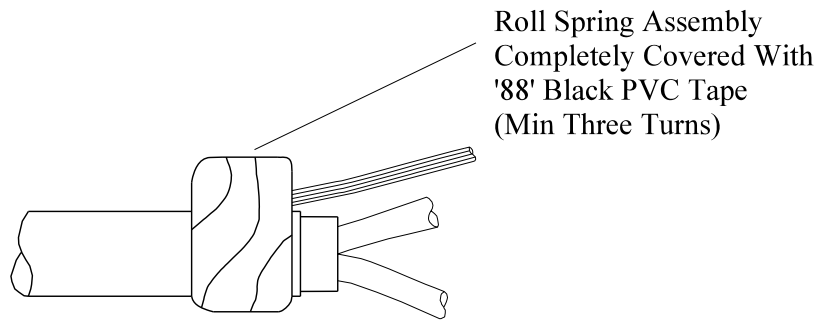



Fig 7



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## GENERAL REQUIREMENT 24

### APPLICATION OF CABLE EARTHING GLANDS FOR ARMOURED CABLES

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

Solidal armoured cables will require bonding to earth at **BOTH** ends; this is undertaken using a gland assembly. The gland assemblies are to be fitted and earthed as shown in GRD.6.24.5

This General Requirement is written to cover single core aluminium wire armoured Solidal cable, the principle of assembly will also cover steel wire armoured multi core cables.

This is undertaken using either of the two sizes of aluminium gland assemblies:-

Kit 422AL58 for 600mm<sup>2</sup>  
Kit 422AL59 for 740mm<sup>2</sup>  
Connector - BET 60-12 - earthing of gland assemblies  
Connector - BET 120-12 - earthing of gland assemblies  
35mm<sup>2</sup> PVC Sheathed (green/yellow) copper conductor -  
earthing of gland assemblies

#### 24.1 Preparation and Installation of Gland – Drawing GRD 6.24.1, GRD 6.24.2, GRD 6.24.3, GRD 6.24.4 GRD 6.24.5

1. Remove the lock nut and earth tag from the gland assembly – Fig 1.
2. Straighten and cut cable to allow sufficient length to suit conductor termination – Fig 2.
3. Remove the inner body from the outer body and feed the inner body through the clearance hole in the gland plate and secure with the lock nut – Fig 3.

**Caution: Do not over-tighten aluminium assemblies aluminium if over-tighten will result with possible thread stripping of cold welding and will make dismantling difficult or impossible when and if required to do so.**

4. Cut the gland shroud to the required dimension of the cable diameter ensuring a push fit and slide over and down the cable – Fig 6.
5. Slacken the captive sealing nut and slide the outer body assembly over the cable - Fig 1 & 4.
6. Offer the cable to the inner body assembly fitted in 3, mark the PVC oversheath 5mm below the cone at point A and remove – Fig 3.

7. Apply a temporary tape binder to the aluminium wire armour, offer the cable to the inner body assembly and mark the aluminium wire armour in line with the shoulder of the cone at point B – Fig 3.
8. Apply a binder at the point of termination, using a depth gauge hacksaw make a circumferential cut at the required position, ensuring the cut is no deeper than half the thickness of the aluminium wire.
9. Remove the temporary tape binder at the cable end, taking each strand in turn bend through 90° and break at the cut position.
10. Remove the binder applied in 8 and lift the aluminium wires away from the core sufficient to allow the cone of the inner gland to slide between the aluminium wires and the core – Fig 4.
11. Remove the inner gland assembly from the gland plate and slide over the core, position the cone between the aluminium wire and the core ensuring the wires lie uniformly around the cone and they are up against the cone shoulder – Fig 4.
12. Assembly the inner and outer bodies of the gland and tighten – Fig 5.
13. Tighten the captive sealing nut ensuring a firm fit onto the PVC oversheath – Fig 6.
14. Feed the cable and gland through the gland plate, slide the earth tag (where required) over the cable onto the gland plate, secure the gland assembly with the lock nut – Fig 6.
15. Slide the gland shroud up the cable and fit into position – Fig 6.

## 24.2 Gland Earthing – Drawing GRD 6.24.5

If the gland plate is of a non-ferrous metal i.e. Aluminium or brass, earth tags are not required only to ensure the gland plate is connected to an appropriate size copper earth conductor.

Where the gland plate is of an insulating material or ferrous metal i.e. steel the glands are to be bonded together and connected to an appropriate size earth conductor.

**Note:** - Where a gland plate is of steel material the plate is to be split to prevent eddy currents.

1. Link each gland assembly via the earth tag using 35mm<sup>2</sup> PVC sheathed (green/yellow) copper conductor inserted into a mechanical connector (one connector will take two conductors).



2. Abrade and apply Penetrox graphite grease to the palm of the earth tag.
3. Bolt link cables into position using brass or stainless steel bolts.
4. Connect the 70mm<sup>2</sup> earth conductor to the last gland assembly and connect to earth.

### 24.3 Bonding Arrangement For PME Connections

For more information or for different bonding arrangements see ST:SD6B

Figure B1 – Arrangement 3, Combined HV and LV Earthing, PME Connection

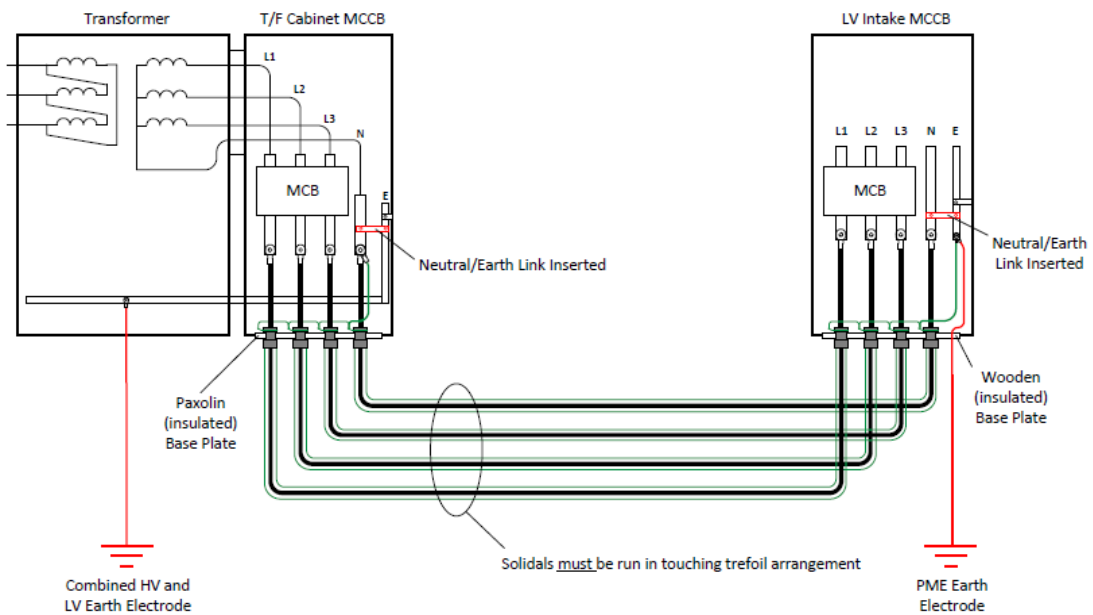
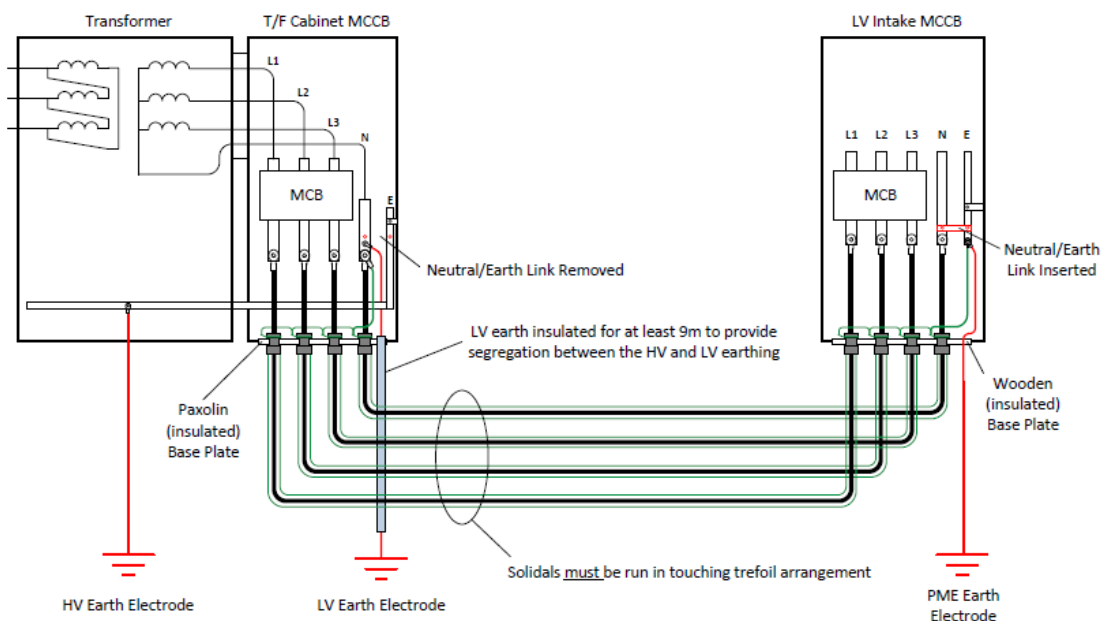
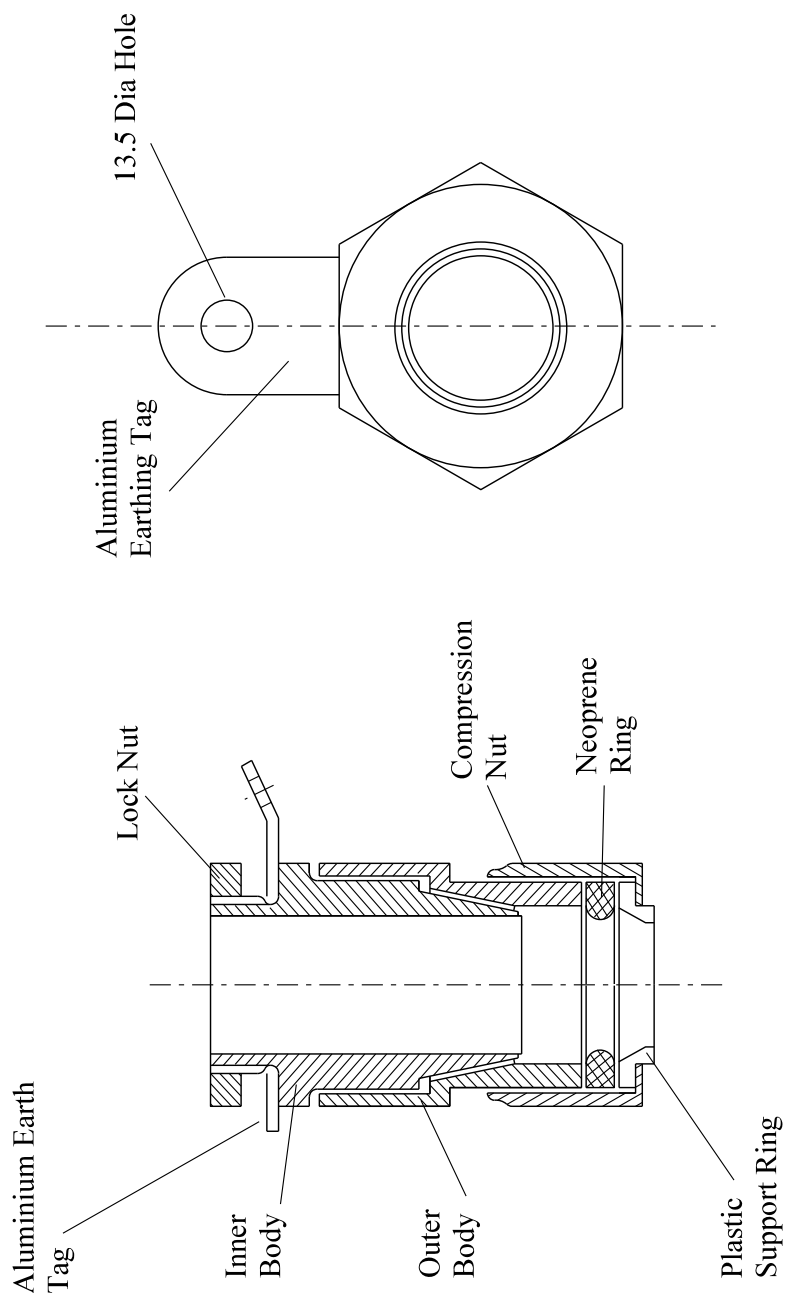



Figure B2 – Arrangement 3, Segregated HV and LV Earthing, PME Connection

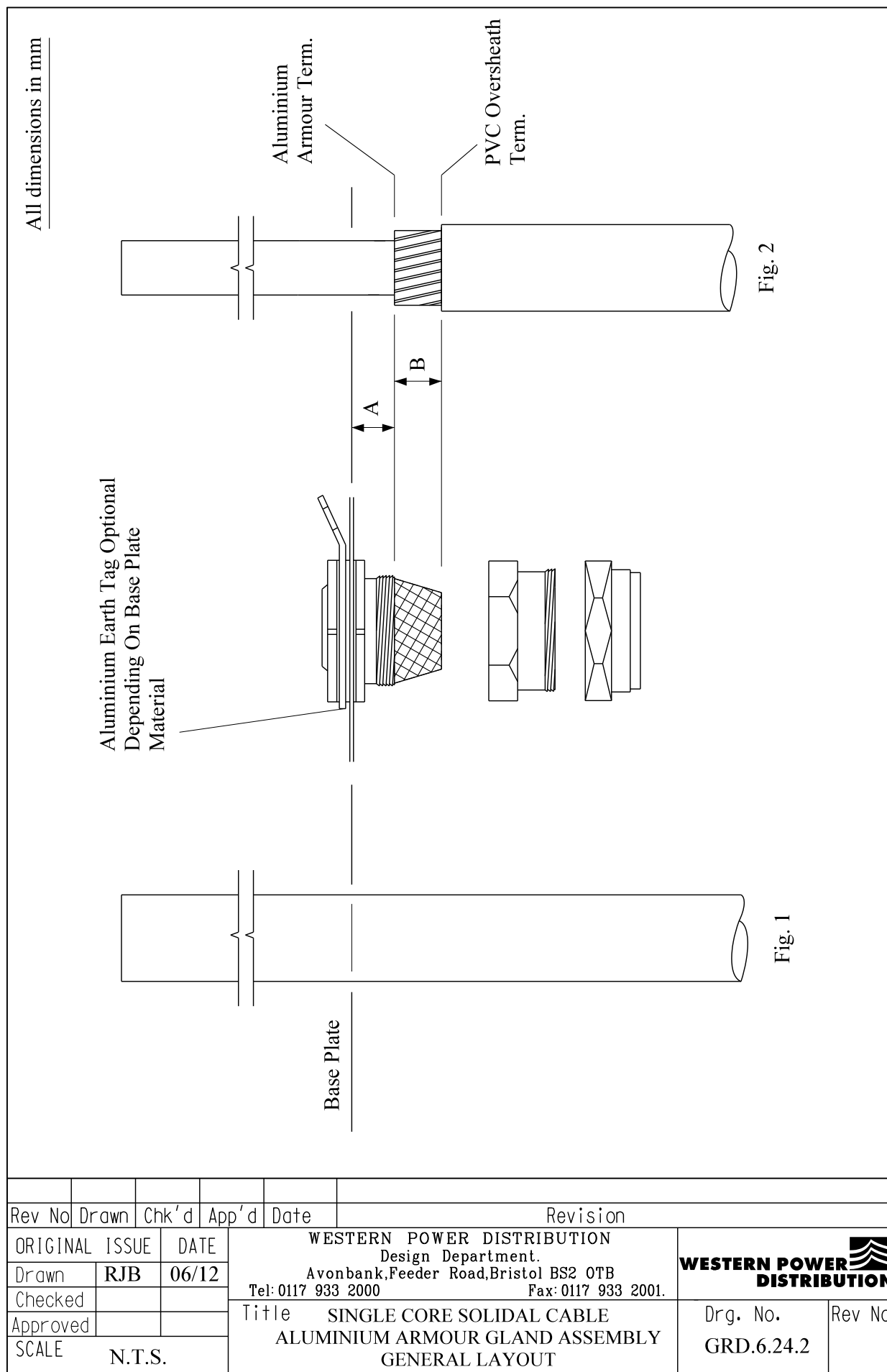


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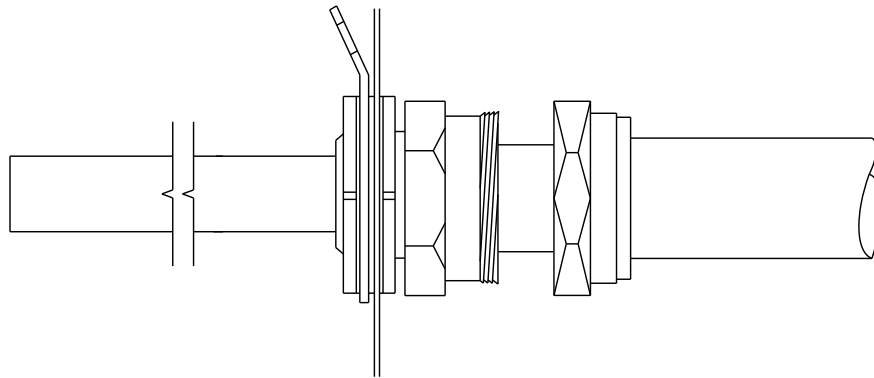


Fig. 4

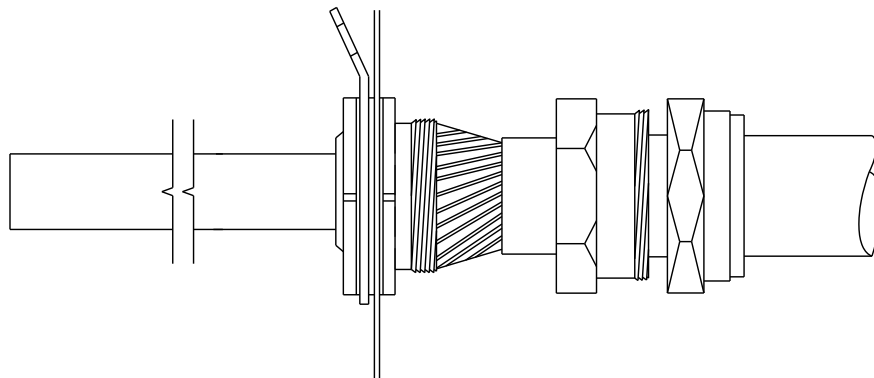



Fig. 3

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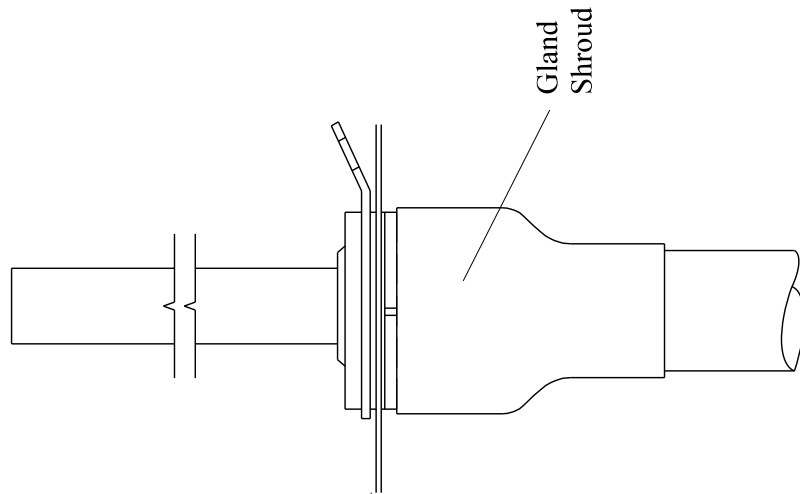


Fig. 6

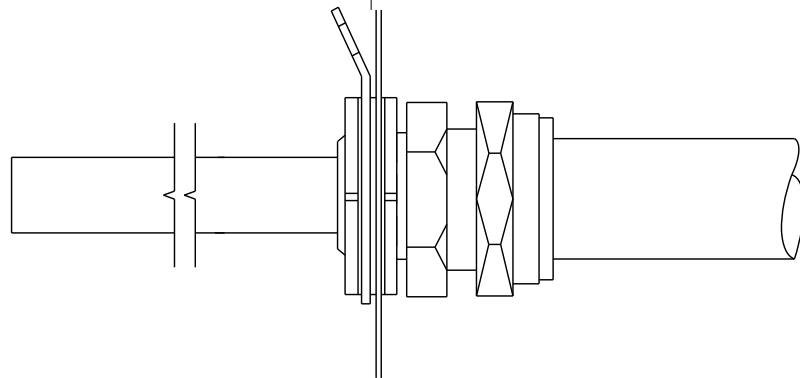

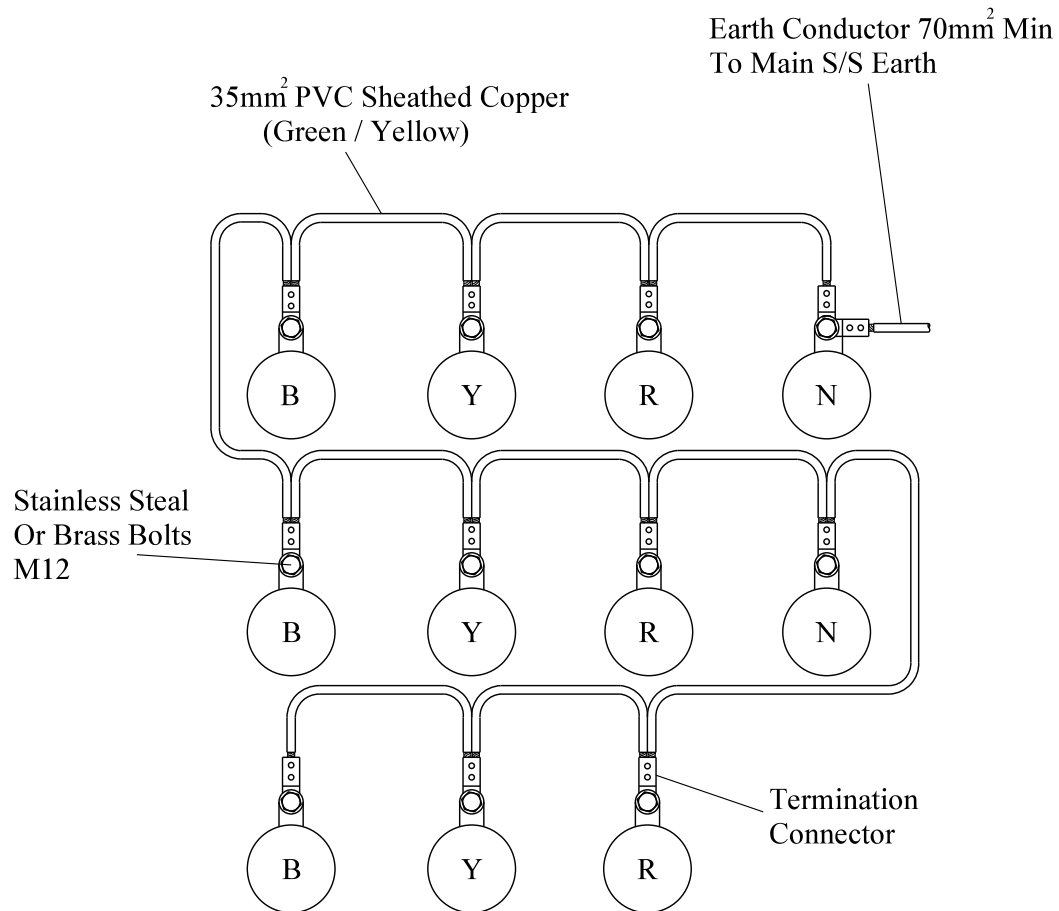


Fig. 5

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**NOTE:- This Arrangement Covers  
4/7/9 Cable Configurations.  
Where Ever Possible The Bonding  
Arrangement Is To Be Undertaken Within The Cable  
Termination Enclosure.**

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## **GENERAL REQUIREMENT 25**

### **PROTECTION OF CORE PAPERS DURING JOINTING**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

Heat shrinkable tubing will be used for core paper protection. It should be applied from the end of the core to a point 10mm for mains 5mm for service cables from the belt paper termination.

The tubing should be shrunk onto the core by application of a gentle flame from an approved gas torch. Care must be taken to ensure that the tubing is not overheated. The flame should be constantly moved along and over the tubing. Shrinking operations should begin at the cable crotch end of the tubing, the flame should be constantly moved along and around the tubing so that no air pockets are formed.

When a mechanical connector is to be fitted, the core papers and protection tubing should be terminated 5mm from the end of the connector.

## **GENERAL REQUIREMENT 26**

### **HEAT SHRINK MATERIALS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

#### **1. General**

It is essential that heat shrink materials are used only in approved situations and that the correct materials are used.

Some materials for 11kV applications look similar to LV materials but may be composed of semi-conducting or conducting material. The packages containing these parts bear warning notices to this effect and under no circumstances may they be used for LV applications.

To avoid mistakes, no surplus materials from kits (particularly 11kV kits) shall be retained. They should be disposed of immediately.

Cleanliness is of the utmost importance particularly where heat-melt adhesive or mastics are concerned. Dirt and grease must not be allowed to contaminate the material. The surface to which a seal is to be made must be thoroughly cleaned with an approved degreaser.

The shrinking operation must be carried out with an approved Gas Torch using a “quiet” blue flame which must be kept moving. The flame should be applied around the component, not along its length, to ensure even shrinkage and to avoid entrapping air bubbles.

Where heat melt adhesive or mastics are involved it will be necessary to apply additional heating to ensure that the adhesive or mastic melts and that a good seal is obtained (keeping the flame moving).

When tubing has to be cut to length before fitting, this should be done in one clean cut, preferably with sharp scissors. Any jaggedness may well lead to the tube splitting when it is shrunk down.

#### **2. Shrinking down breakouts**

Push the breakout firmly down into the crutch.

Start at the waist so that it shrinks into the crutch. Continue down the skirt to grip the cable sheath. Finish off with the fingers so that they grip the cores.



### **3. Shrinking down tubing on paper insulated cores**

This will only be necessary, in the future, for core paper protection, since it is not intended that terminations will be made on Consac or PILC cables.

Slide the tubing over the core. Shrink a 50mm length of the end nearest the crutch. Slide the tube into the crutch, rotating in the direction of the lay of the papers. Shrink down the remainder of the tubing.

## **GENERAL REQUIREMENT 27**

### **SETTING CORES INTO THE JOINTING POSITION**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

In a straight joint, if one cable end is an A (clockwise) and the other is a Z (anti-clockwise) no cross will result. If however both ends are the same (both A's or both Z's) a cross will result.

All joints have been designed to allow crosses to be made, if necessary.

In transition straight joints between Wavecon and paper-insulated cables the cross must be made on the Wavecon side.

If it is necessary approved insulated core twisters can be used

Where crosses have to be made in paper-insulated cores, (e.g. in branch joints) heat-shrink tubing must be applied to prevent damage to the paper General Requirement 25.

When setting cores into their final position remember that sufficient straight core must be provided to allow the mechanical connector to be fitted on.

## GENERAL REQUIREMENT 28

### SAFE REMOVAL OF INSULATION FROM CABLE CORES

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

#### 28.1 General

Care must be exercised when removing insulation from cores during jointing, to avoid flashovers. The flashovers are generally initiated by the simultaneous cutting of insulation on two cores by opposite sides of the knife or by driving the knife point into another core. **Metal blade knives must not be used to remove core insulation**

Core insulation should only be removed by tearing or cutting with the approved insulated ceramic core knife. The knife should not require sharpening but it can be 'touched up' using a diamond encrusted sharpening tool. Knives should be replaced when damaged.

When removing insulation from a core to minimise the risk of simultaneously cutting the insulation of another core, a core guard wedge or a piece of PVC oversheath must be used to protect the insulation of cores not being worked on. This particularly includes the rubber patch insulation around the connectors. Under no circumstances should the knife blade be heated as this may shatter the blade.

It is also emphasised that approved shrouding must be applied to all exposed earth metalwork, in accordance with General Requirement 21

## **GENERAL REQUIREMENT 29**

### **APPLICATION OF MECHANICAL CONNECTORS IN JOINTS AND TERMINATIONS**

All connections on the LV underground distribution system whether straight, branch, loop or termination for mains or service cables, will be made using mechanical shear bolt or screw connectors/lugs.

They cover all cable types such as Wavecon, Consac, PILC, Solidal and PVC Concentric.

Your attention is drawn to the need to comply to General Requirement 3 “General Jointing Procedures and Safety Precautions – Live Cables”, Distribution Safety Rules “Section 8” and make correct and proper use of the level of Personal Protective Equipment as given in the matrix General Requirement 3, also the Use of Solvents General Requirement 1.

The following given connectors apply equally to all cable types unless stated otherwise: -

### **MAINS CABLE CONNECTIONS (50 – 960mm<sup>2</sup>).**

#### **1. STRAIGHT JOINTS**

##### **Phase connections:-**

All cable types (50 - 300mm <sup>2</sup> )	- UST connector
All cable types (480 - 960mm <sup>2</sup> )	- MFC connector

##### **Neutral Connections (SNE):-**

4 core Wavecon to PILC	- UST connector
4 core Wavecon to 4 core Wavecon	- UST connector
Solidal to PILC	- ML connector
Solidal to Solidal	- ML connector

##### **Neutral/Earth Connections (CNE):-**

3 core Wavecon to PILC	- UST connector
3 core Wavecon to 4 core Wavecon	- UST connector
3 core Wavecon to 3 core Wavecon	- BCNE connector
3 core Wavecon to Consac	- TA connector

### **Earth Connections (SNE):-**

- 4 core Wavecon to PILC - BCNE connector
- 4 core Wavecon to 4 core Wavecon - BCNE connector

## **2. STRAIGHT JOINTS INCLUDING SERVICES**

### **Phase Connections:-**

- All cable types - UBTI conversion plate

### **Neutral Connection (SNE):-**

- 4 core Wavecon to PILC - UBTI conversion plate
- 4 core Wavecon to 4 core Wavecon - UBTI conversion plate

### **Neutral/Earth Connections (CNE):-**

- 3 core Wavecon to PILC - BCNE connector
- 3 core Wavecon to 4 core Wavecon - BCNE connector
- 3 core Wavecon to 3 core Wavecon - BCNE connector
- 3 core Wavecon to Consac - BCNE connector

### **Earth Connections (SNE):-**

- 4 core Wavecon to PILC - BCNE connector
- 4 core Wavecon to 4 core Wavecon - BCNE connector

## **3. BRANCH JOINTS – UNCUT MAIN**

### **Phase Connections:-**

- All cable types (50 – 300mm<sup>2</sup>) - UBR connector

### **Neutral Connections (SNE):-**

- 4 core Wavecon to PILC - UBR connector
- 4 core Wavecon to 4 core Wavecon - UBR connector

### **Neutral/Earth Connections (CNE):-**

3 core Wavecon to PILC	- UBR connector
3 core Wavecon to 4 core Wavecon	- UBR connector
3 core Wavecon to 3 core Wavecon	- BCNE connector
3 core Wavecon to Consac	- TA connector

### **Earth Connection (SNE):-**

4 core Wavecon to PILC	- BCNE connector
4 core Wavecon to 4 core Wavecon	- BCNE connector

## **4. BRANCH JOINTS – CUT MAIN**

### **Phase Connections:-**

All cable types (50 - 300mm <sup>2</sup> )	- UBRD connector
--	------------------

### **Neutral Connections (SNE):-**

4 core Wavecon to PILC	- UBRD connector
4 core Wavecon to 4 core Wavecon	- UBRD connector

### **Neutral/Earth Connections (CNE):-**

3 core Wavecon to PILC	- UBR connector
3 core Wavecon to 4 core Wavecon	- UBR connector
3 core Wavecon to 3 core Wavecon	- BCNE connector
3 core Wavecon to Consac	- TA connector

### **Earth Connections (SNE):-**

4 core Wavecon to PILC	- BCNE connector
4 core Wavecon to 4 core Wavecon	- BCNE connector

## **5. LOOP JOINTS**

### **Phase Connections:-**

All cable types (50 - 300mm<sup>2</sup>) - UBR connector

### **Neutral Connections (SNE):-**

4 core Wavecon to PILC - UBR connector  
4 core Wavecon to 4 core Wavecon - UBR connector

### **Neutral/Earth Connections (CNE):-**

3 core Wavecon to PILC - UBR connector  
3 core Wavecon to 4 core Wavecon - UBR connector  
3 core Wavecon to 3 core Wavecon - BCNE connector  
3 core Wavecon to Consac - TA connector

### **Earth Connection (SNE):-**

4 core Wavecon to PILC - BCNE connector  
4 core Wavecon to 4 core Wavecon - BCNE connector

## **6. MAINS SERVICE JOINTS**

### **Phase Connections:-**

All cable types (50 - 300mm<sup>2</sup>) - MSIP connector

### **Neutral Connections (SNE):-**

PILC - MSIP connector  
4 core Wavecon - MSIP connector

### **Neutral/earth connections (CNE):-**

PILC - MSIP connector  
4 core Wavecon - MSIP connector  
3 core Wavecon - BCNE connector  
Consac - TA connector

### **Earth connections (SNE):-**

PILC	- BCNE connector
4 core Wavecon	- BCNE connector

## **7. TERMINATIONS**

### **INDOOR TERMINATIONS**

#### **Phase Connections:-**

3 core Wavecon	- LVET lug
4 core Wavecon	- LVET lug
Solidal	- ML lug

#### **Neutral Connections (SNE):-**

4 core Wavecon	- LVET lug
Solidal	- ML lugs

#### **Neutral/Earth Connections (CNE):-**

3 core Wavecon	- BET lugs
----------------	------------

#### **Earth Connections (SNE):-**

4 core Wavecon	- BET lugs
Solidal	- BET lugs

### **HD CUT-OUT TERMINATIONS**

#### **Phase Connections:-**

3 Core Wavecon	- UT connector
4 Core Wavecon	- UT connector

#### **Neutral Connections (SNE):-**

4 Core Wavecon	- LVET lug
----------------	------------



### **Neutral/Earth Connections (CNE):-**

3 Core Wavecon	- BCNE connector
----------------	------------------

### **Earth Connections (SNE):-**

4 Core Wavecon	- BET lug
----------------	-----------

## **OUTDOOR TERMINATIONS**

### **Phase Connections:-**

3 core Wavecon	- HVSTM connectors
4 core Wavecon	- HVSTM connectors

### **Neutral Connections (SNE):-**

4 core Wavecon	- HVSTM connectors
----------------	--------------------

## **LDB TERMINATIONS**

### **Phase Connections:-**

3 core Wavecon	- UT connector
4 core Wavecon	- UT connector

### **Neutral Connections (SNE):-**

4 core Wavecon	- UT connector
----------------	----------------

### **Neutral/Earth Connections:-**

3 core Wavecon	- UT connector
----------------	----------------

### **Earth Connection (SNE):-**

4 core Wavecon	- UT connector
----------------	----------------

## **APPLICATION OF CONNECTORS – INDEX**

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## UST CONNECTOR (Phase Neutral and Neutral/Earth Connectors)

These connectors are to be used in all mains straight joints on aluminium and copper stranded or solid 90° and 120° sectioned or round conductors up to the maximum cross section for which the connector is designed.

There are three connectors in the range and are of shear bolt design, they range take across specific conductor sizes as follows:-

- UST 95 covers 35 - 95mm<sup>2</sup> conductors
- UST 185 covers 35 - 185mm<sup>2</sup> conductors
- UST 300 covers 70 - 300mm<sup>2</sup> conductors

Special bolts are available to cover smaller conductor sizes for the UST 300 connector.

Brass gauze can be used to wrap copper conductors and is recommended for small or loosely compacted conductors.

Tooling - the UST 95 requires a 13mm socket and the UST 185 and UST 300 requires a 19mm socket which may be attached to either a power driven tool or a ratchet spanner, the connector is held stable whilst shearing with a adjustable holding tool.

All tooling used is to be fully insulated and company approved.

### Connector Installation (UST) - Drawing GRD 6.29.2

When making phase connections each phase must be dealt with in turn. Remove insulation, make the connection and reinsulate **before** commencing the operation on the next phase.

1. Cut each core so that it will occupy half the length of the connector.
2. Remove the insulation from each conductor to a position half the length of the connector plus 5mm.
3. Use approved insulated core twisting tools to align conductors if required.
4. Degrease the conductor if necessary.
5. Using a file card abrade any aluminium conductor.
6. Position the connector on one conductor slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.
7. Insert the remaining conductor(s) into the connector, slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.

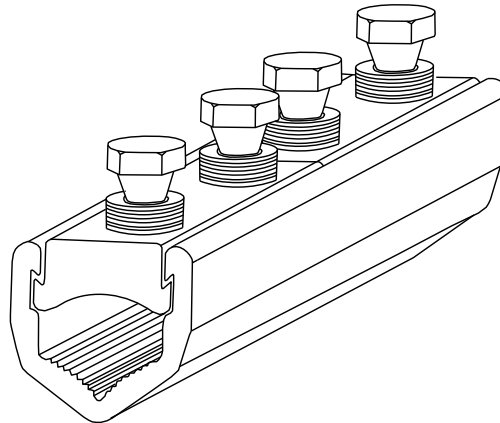
### **Connector Installation (UST) - Continued**

8. Holding the connector with an approved insulated holding tool tighten the bolts evenly until they shear.
9. Prepare and install the insulation patch / shroud to the dimensions given in General Requirement 30.

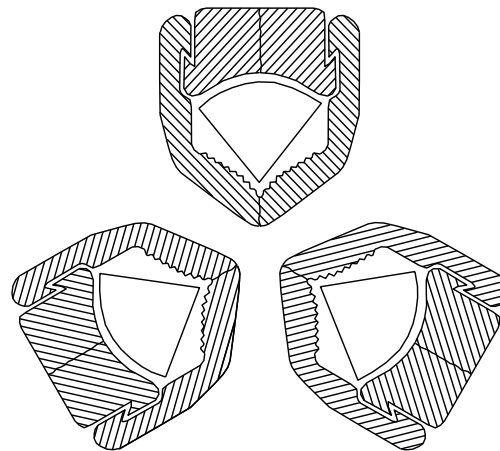
**NOTE: - When making neutral/earth connections the 35mm<sup>2</sup> copper PVC sheathed conductor will require incorporating into the connector.**

All dimensions in mm


# UST Connector



## Connector Setup For Three or Four Core Stranded And Solid Mains Cable



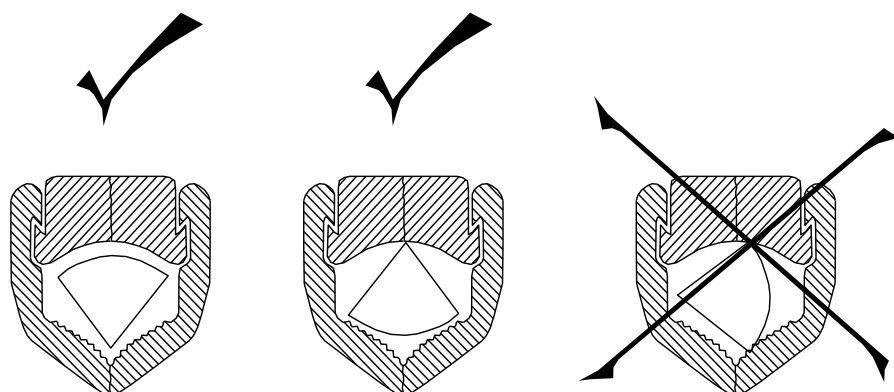
## End View Through Short Side Of Joint

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SCALE		N.T.S.		Title	
				INSTALLATION OF UST CONNECTOR - STRAIGHT JOINT	
				Drg. No. GRD 6.29.1	
				Rev No	

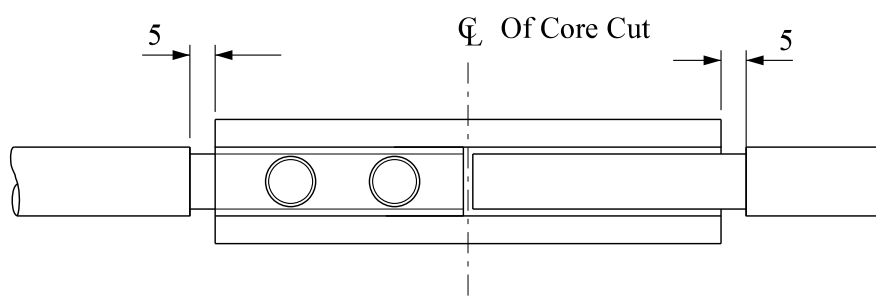
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All dimension in mm


### Conductor Setup Within Connector (Solid Only)



Stranded Sector Shaped Conductors May Be Rounded To Ease Installation



Copper Conductors Are To Be Wrapped With Brass Gauze

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						Rev No

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## MLCONNECTORS (Phase and Neutral Connections)

These connectors are to be used in single core straight joints on aluminium and copper stranded or solid round conductors up to the maximum cross section for which the connector is designed.

These are two connectors in the range and are of shear bolt design, which range take across specific conductor sizes as follows:-

ML 7	covers 480 - 630mm <sup>2</sup> conductors
ML 8	covers 740 - 960mm <sup>2</sup> conductors

Brass gauze is to be used when connecting copper conductors.

All tooling used on these connectors must be approved and insulated.

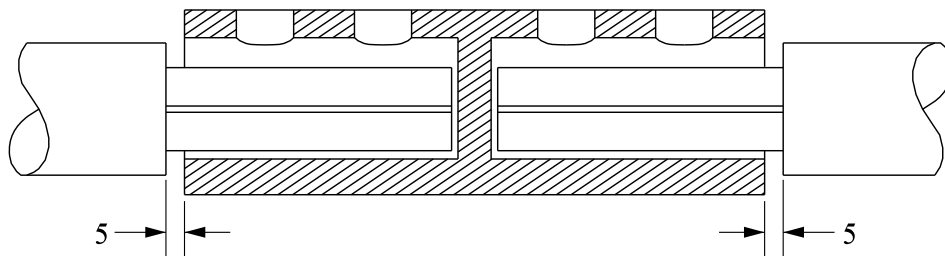
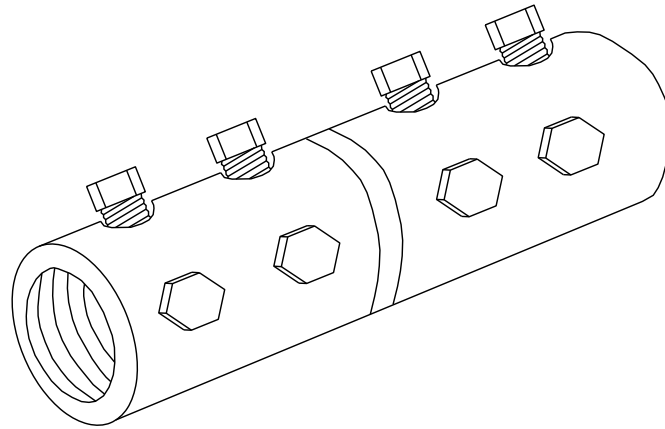
### Connector Installation (ML) - Drawing GRD 6.29.3

These connectors are for **dead working** only


1. Cut each core at the core guide position, so that it will occupy the depth of the core.
2. Remove the insulation from each core to a position equal to the core depth plus 5mm.
3. Degrease the conductor if necessary.
4. Using a file card abrade any aluminium conductors.
5. Insert the conductors into the connector and finger tighten the bolts, if stranded copper wrap with brass gauze.
6. Supporting the connector tighten the bolts evenly until they shear.
7. Prepare and install the insulation patch/shroud to the dimensions given in General Requirement 30.

All dimensions in mm

MF Connector



Copper Conductors Are To Be Wrapped With Brass Gauze

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## UST CONNECTOR – INCLUDING SERVICES (Phase, Neutral Connections)

The connector to be used is the UST range when a service entry is required a conversion plate is to be used, as follows:-

USBTI 95  
USBTI 185  
USBTI 300

The conversion bridge pieces allows one service entry per plate and covers service cables up to and including 35mm<sup>2</sup> and is retained in the service port by a non-shear grab screws. There will be the need at times for two bridge pieces per connector i.e. neutral connections.

A conversion bridge is exchanged with one of the bridge pieces supplied with the connector, shear bolts are transferred to the conversion plate and the original bridge discarded.

Tooling - the connector is installed using tooling as detailed in UST connector, the service grub screw requires an approved 3mm insulated tee bar for tightening.

All tooling used on these connectors must be approved and insulated.

### Connector Installation (UST inc. Services) - Drawing GRD 6.29.4

When making phase connections each phase must be dealt with in turn. Remove insulation, make connection and reinsulate **before** commencing the operation on the next phase.

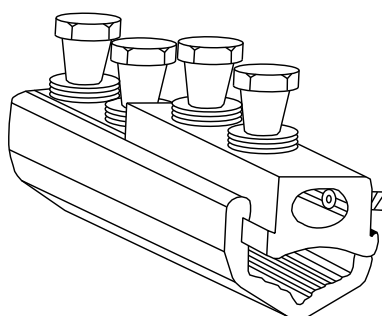
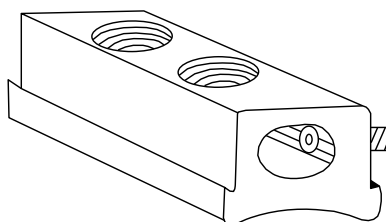
1. Cut each core so that it will occupy half the length of the connector.
2. Remove the insulation from each conductor to a position half the length of the connector plus 5mm.
3. Use an approved insulated core twisting tools to align conductors if required.
4. Degrease the conductor if necessary.
5. Using an approved insulated file card abrade any aluminium conductor.
6. Position the connector on one conductor slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.
7. Insert the remaining conductor(s) into the connector, slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.
8. Holding the connector with an approved insulated tool tighten the bolts evenly until they shear.
9. Cut the service core so that it will fully occupy the entry.
10. Remove the insulation the depth of the entry plus 5mm.

### **Connector Installation (UST/Services - Continued)**

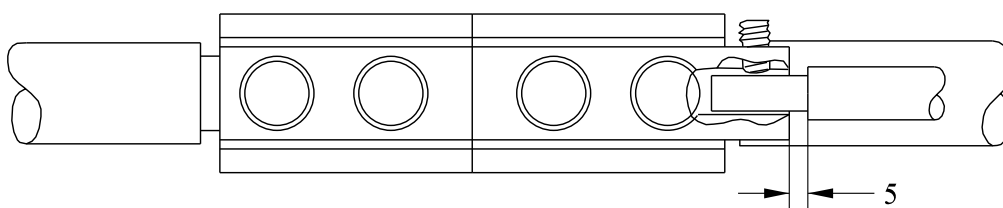
11. Using an approved insulated file card, abrade any aluminium conductor.
12. Insert the service conductor into the entry and fully tighten the grub screw, if stranded copper wrap with brass gauze.
13. Prepare and install the insulation patch to the dimensions given General Requirement 30.

All dimensions in mm

USBTI Plate



UST Connector Converted To Take Service Conductor



Copper Conductors Are To Be Wrapped With Brass Gauze

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				INSTALLATION OF USBTI	
				CONVERSION PLATE - SERVICE BRANCH	
				IN MAINS STRAIGHT JOINT	
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## UBR CONNECTORS (Phase, Neutral and Neutral/Earth Connections)

These connectors are to be used in all uncut mains branch joints on aluminium and copper stranded or solid 90° and 120° sectoral or round conductors up to the maximum cross section for which the connector is designed.

There are three connectors in the range and are of sheer bolt design which range takes across specific conductor sizes as follows: -

- UBR 95 cover 35 - 95mm<sup>2</sup> conductors
- UBR 185 cover 35 - 185mm<sup>2</sup> conductors
- UBR 300 cover 70 - 300mm<sup>2</sup> conductors

Special bolts are available to cover smaller conductor sizes for the UBR 300 connector.

Brass gauze can be used to wrap copper conductors and is recommended for small or loosely compacted conductors.

Tooling - the UBR 95 requires a 13mm socket and the UBR 185 and UBR 300 requires a 19mm socket which may be either a power driven tool or a ratchet spanner, the connector is held stable whilst shearing with a holding tool, one size covers the UBR 95 whilst a larger size covers the UBR 185 and UBR 300.

All tooling used on these connectors must be approved and insulated

### Connector Installation (UBR) – Drawing GRD 6.29.5, 6.29.6

When making phase connections each phase must be dealt with in turn. Remove insulation, make connection and reinsulate **before** commencing the operation on the next phase.

For paper insulated mains cable, the insulation must be tied off before it is cut to prevent the papers unwrapping.

1. Cut the branch core so that it will overlap through the connector by 5mm.
2. Remove the insulation from each conductor to a position 5mm either side of the connector ends.
3. Use an approved insulated core twisting tools to align conductors if required.
4. Degrease the conductor if necessary.
5. Using an approved insulated file card abrade any aluminium conductor.
6. Position the connector on one conductor slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.

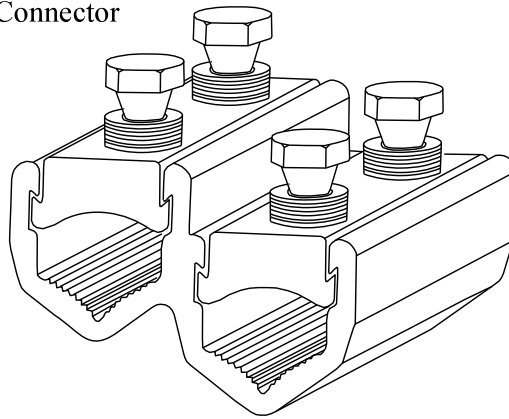
### **Connector Installation (UBR) - Continued**

7. Insert the remaining conductor into the connector, slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.
8. Holding the connector with an approved insulated tool tighten the bolts evenly until they shear.
9. Prepare and install the insulation patch to the dimensions given in General Requirement 30.

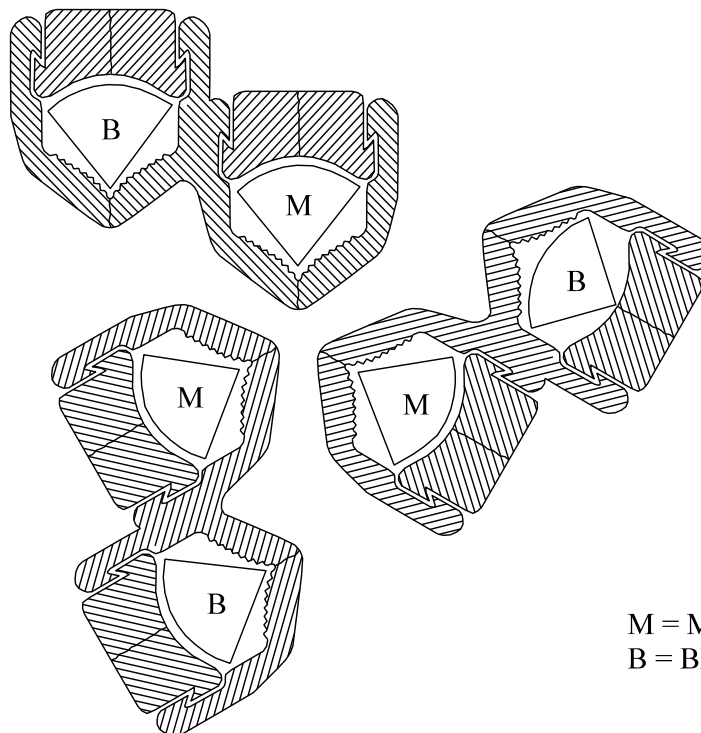
**NOTE: - When making neutral/earth connections the 35mm<sup>2</sup> copper PVC sheathed conductor will require incorporating into the connector.**

All dimensions in mm


UBR Connector



Connector Setup For Three or Four Core Stranded And Solid Mains Cable



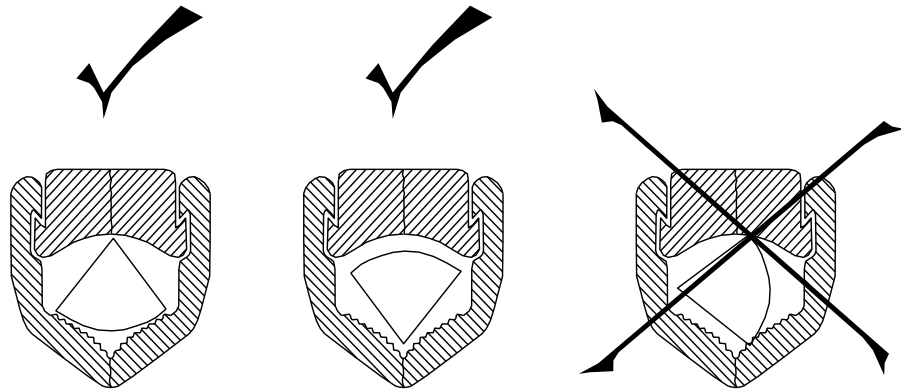
M = MAIN  
B = BRANCH

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				INSTALLATION OF UBR CONNECTOR - BRANCH JOINT	
				Drg. No. GRD 6.29.5	
				Rev No	

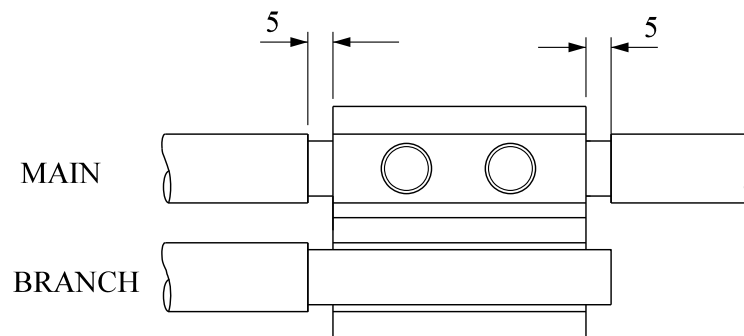
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All dimension in mm


### Conductor Setup Within Connector (Solid Only)



Stranded Sector Shaped Conductors May Be Rounded To Ease Installation



Copper Conductors Are To Be Wrapped With Brass Gauze

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Drawn	RJB	06/12			
Checked				Title <div>INSTALLATION OF UBR CONNECTOR BRANCH JOINT</div> <div>Drg. No. GRD 6.29.6</div> <div>Rev No</div>	
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SCALE		N.T.S.			

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## UBRD CONNECTORS (Phase, Neutral and Neutral/Earth Connections)

These connectors are to be used in all cut main branch joints on aluminium and copper, stranded or solid 90° and 120° sectional or round conductors up to the maximum cross section for which the connector is designed.

There are three connectors in the range and are of shear bolt design, which range take across specific conductor sizes as follows:-

UBRD 95 covers 35 - 95mm<sup>2</sup> conductors

UBRD 185 covers 35 - 185mm<sup>2</sup> conductors

UBRD 300 covers 70 - 300mm<sup>2</sup> conductors

Special bolts are available to cover smaller conductor sizes for the UBRD 300 connector.

Brass gauze can be used to wrap copper conductors and is recommended for small or loosely compacted conductors.

Tooling - the UBRD 95 requires a 13mm socket and the UBRD 185 and UBRD 300 required a 19mm socket which may be either power driven or a ratchet spanner.

All tooling used is to be fully insulated and company approved.

### Connector Installation (UBRD) - Drawing GRD 6.29.7

When making phase connections each phase must be dealt with in turn. Remove insulation, make connection and reinsulate **before** commencing the operation on the next phase.

This connector forms a straight and branch joint in one, and is prepared and installed in two parts.

#### Straight Side of Connector

1. Taking a core from each side of the joint cut so that they will occupy half the length of the connector.
2. Remove the insulation from each conductor to a position half the length of the connector plus 5mm.
3. Use an approved insulated core twisting tools to align conductors if required.
4. Degrease the conductor if necessary.
5. Using an approved insulated file card abrade any aluminium conductor.
6. Position the connector on one conductor, slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.
7. Insert the remaining conductor into the connector, slide the bridge into place and finger tighten the bolts, if stranded copper wrap in brass gauze.

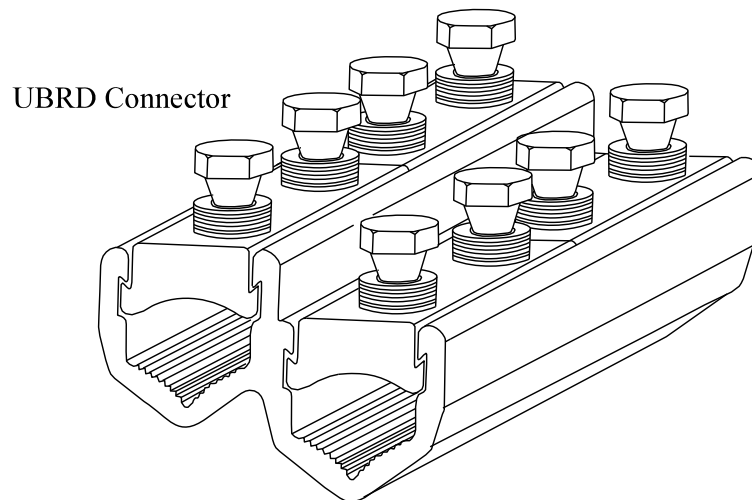


### **Branch Side of Connector**

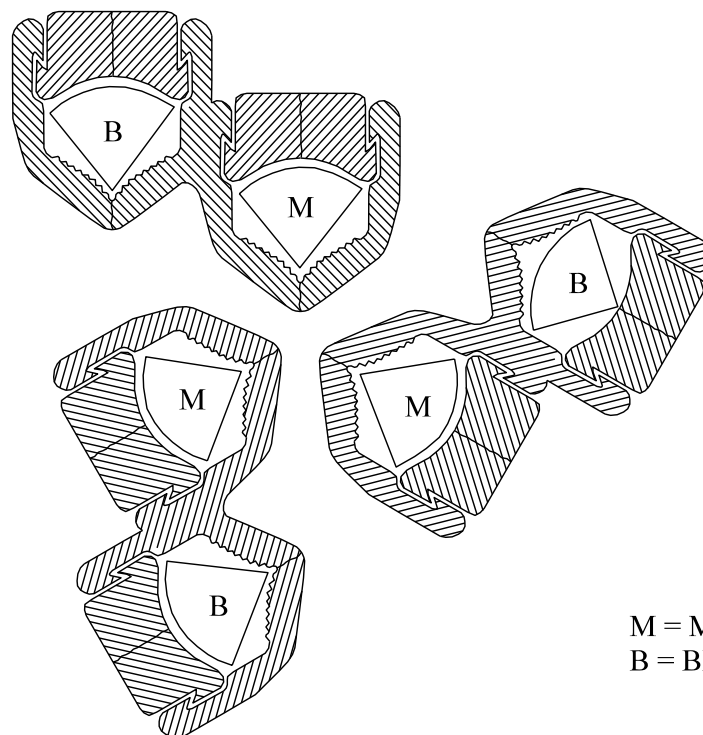
8. Cut the branch core so that it will overlap through the connector by 5mm.
9. Remove the insulation from the conductor 5mm from edge of the connector.
10. Use an approved insulated core twisting tools to align conductors if required
11. Degrease the conductor if necessary.
12. Using an approved insulated file card abrade any aluminium conductor.
13. Insert the remaining conductor into the connector, slide the two bridge pieces into place and finger tighten the bolts, if stranded copper wrap on brass gauze.
14. Supporting the connector tighten the bolts evenly until they shear.
15. Prepare and install the insulation patch / shroud to the dimensions given in General Requirement 30.

**NOTE: - When making neutral/earth connections the 35mm<sup>2</sup> copper PVC sheathed conductor will require incorporating into the connector.**

All dimensions in mm



Connector Setup For Three Or Four Core Stranded And Solid Mains Cable



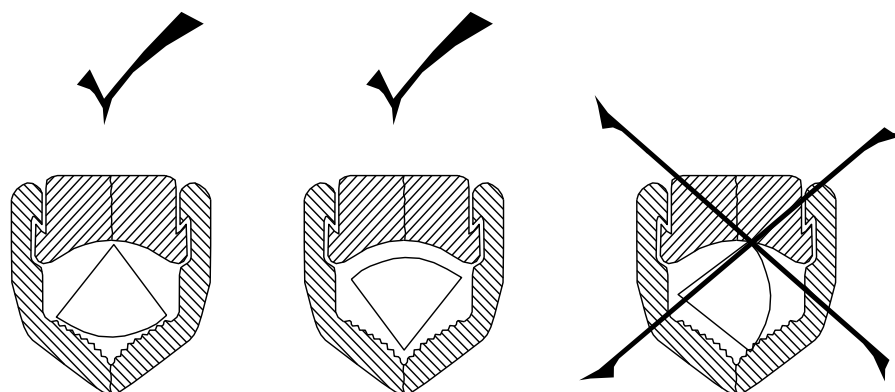
M = MAIN  
B = BRANCH

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SCALE		N.T.S.		Title	
				INSTALLATION OF UBRD CONNECTOR - CUT MAIN BRANCH JOINT	
				Drg. No. GRD 6.29.7	
				Rev No	

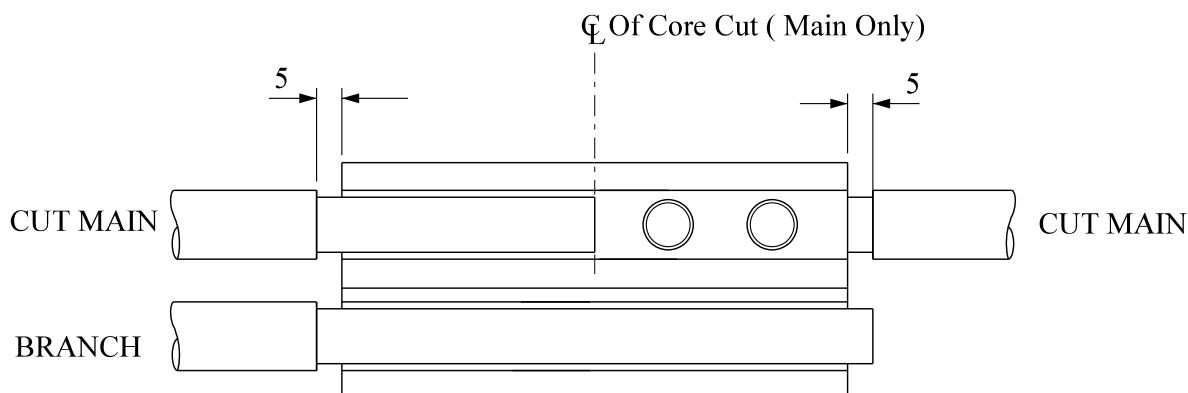
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All dimension in mm


### Conductor Setup Into Connector (Solid Only)



Stranded Sector Shaped Conductors May Be Rounded To Ease Installation



Copper Conductors Are To Be Wrapped With Brass Gauze

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## UBR CONNECTORS (Phase, Neutral and Neutral/Earth Connections)

These connectors are to be used in all mains loop joints on aluminium and copper stranded or solid 90° and 120° sectoral or round conductors up to the maximum cross section for which the connector is designed.

There are three connectors in the range and are of sheer bolt design which range takes across specific conductor sizes as follows:-

- UBR 95 cover 35 - 95mm<sup>2</sup> conductors
- UBR 185 cover 35 - 185mm<sup>2</sup> conductors
- UBR 300 cover 70 - 300mm<sup>2</sup> conductors

Special bolts are available to cover smaller conductor sizes for the UBR 300 connector.

Brass gauze can be used to wrap copper conductors and is recommended for small or loosely compacted conductors.

Tooling - the UBR 95 requires a 13mm socket and the UBR 185 and UBR 300 requires a 19mm socket which may be either a power driven tool or a hatchet spanner, the connector is held stable whilst shearing with a holding tool, one size covers the UBR 95 whilst a larger size covers the UBR 185 and UBR 300.

All tooling used is to be fully insulated and company approved.

### Connector Installation (UBR) - Drawing GRD 6.29.9, 6.29.10

When making phase connections each phase must be dealt with in turn. Remove insulation, make connection and reinsulate **before** commencing the operation on the next phase.

1. Cut both branch cores so that they will overlap through the connector by 5mm.
2. Remove the insulation from each conductor to a position 5mm from the connector end.
3. Use an approved insulated core twisting tools to align conductors if required.
4. Degrease the conductor if necessary.
5. Using an approved insulated file card abrade any aluminium conductor.
6. Position the connector on one conductor slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.
7. Insert the remaining conductor into the connector, slide the bridge into place and finger tighten the bolts, if stranded copper wrap with brass gauze.

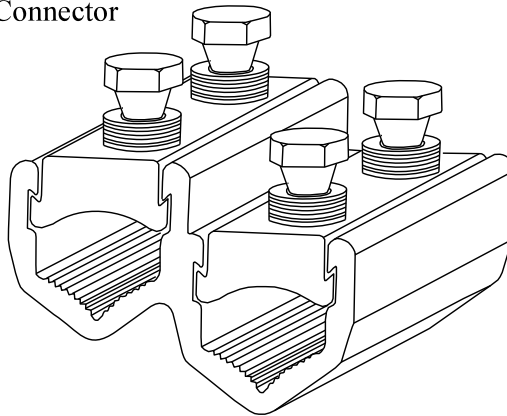
### **Connector Installation (UBR) - Continued**

8. Holding the connector with an approved insulated holding tool tighten the bolts evenly until they shear.
9. Prepare and install the insulation patch / shroud to the dimensions given in the General Requirement 30.

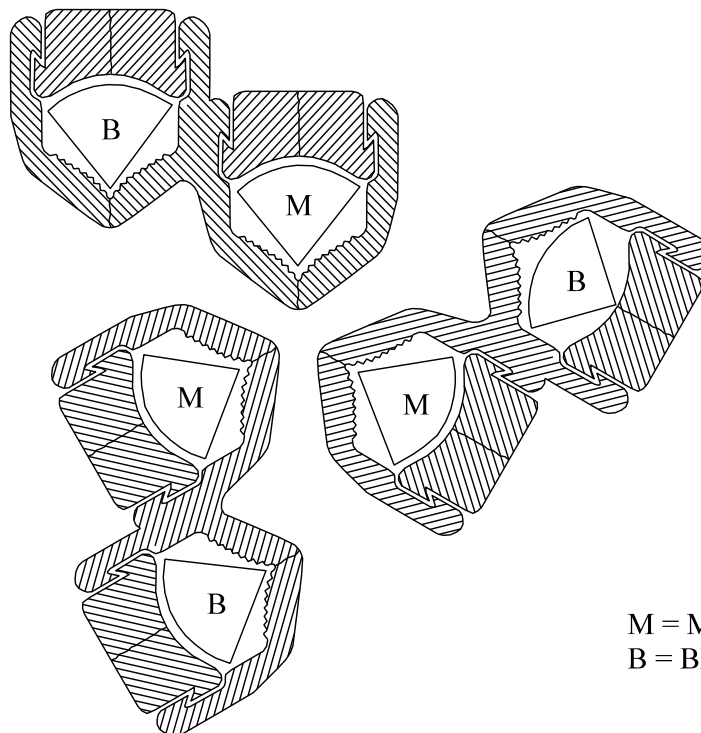
**NOTE: - When making neutral/earth connections the 35mm<sup>2</sup> copper PVC sheathed conductor will require incorporating into the connector.**

All dimensions in mm


UBR Connector



Connector Setup For Three Or Four Core Stranded And Solid Mains Cable



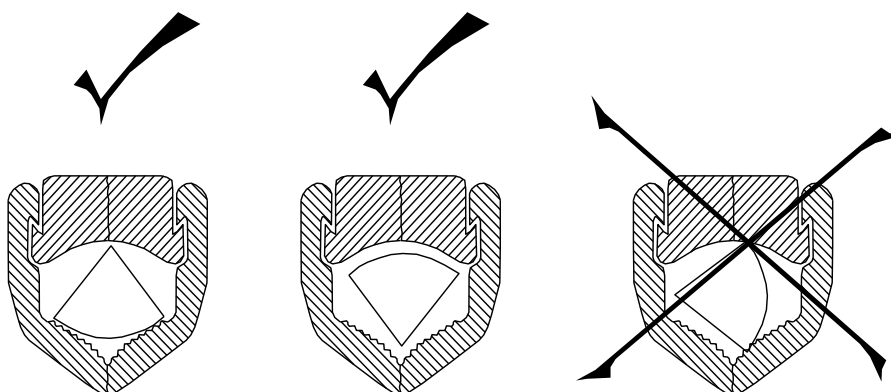
M = MAIN  
B = BRANCH

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SCALE		N.T.S.		INSTALLATION OF UBR CONNECTOR - LOOP JOINT	
				Drg. No.	Rev No
				GRD 6.29.9	

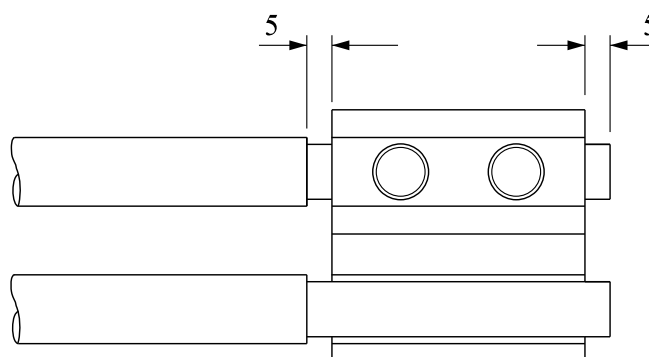
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All dimension in mm


### Conductor Setup Within Connector (Solid Only)



Stranded Sector Shaped Conductors May Be Rounded To Eases Installation



Copper Conductors Are To Be Wrapped With Brass Gauze

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## MSIP CONNECTOR (Phase, Neutral and Neutral/Earth Connections)

These connectors are to be used in all mains service joints on aluminium and copper stranded or solid 90° and 120° sectional or round conductors up to the maximum cross section for which the connector is designed.

There are two connectors in the range and range take across specific conductor sizes as follows:-

MSIP 50 - 185 covers 50 - 185mm<sup>2</sup> conductor  
MSIP 185 - 300 covers 185 - 300mm<sup>2</sup> conductor

Each connector has two service entries which takes a maximum of 2 x 25mm<sup>2</sup> stranded copper or 2 x 35mm<sup>2</sup> solid aluminium or 1 x 35mm<sup>2</sup> stranded copper depending on main cable size.

When utilising the 50-185mm<sup>2</sup> B&H Mains-Service Insulated Insulation Piercing Connector on imperial sized copper conductor below 95mm<sup>2</sup>, it will be necessary to utilise a special insulation piercing bolt, in order to avoid damaging the fine strands of the conductor.

The connector is insulation piercing on the main only, service cables require removal of the insulation before insertion into the service entry which is then retained by a non-shear grub screw.

Tooling - the insulation piercing shear bolt requires a 19mm socket which may be attached to a power driven tool or ratchet spanner, the connector is held stable whilst shearing with a holding tool. The service grub screw requires a 3mm Allen key for tightening.

All tooling used is to be fully insulated and company approved.

### Connector Installation (MSIP) – Drawing GRD 6.29.11

1. Split the connector into two parts by sliding the main body sideways, the main body will then lift away from the saddle. **Do not attempt to remove the plastic hexagonal drive head of the bolt or unscrew the bolt out of the main body.**
2. Remove the plug from one of the service ports and retain it for use in stage 8. Remove the plug from the second service port if the connector is to be used for a double service take-off.
3. Unscrew the main piercing bolt until it is level with the underside of the main connector body. Do not unscrew it further. Also unscrew the service take-off clamping screws on the service port or ports to be used.
4. Fit the saddle of the connector around the core at the required position.



### Connector Installation (MSIP) - Continued

5. Holding the saddle with one hand, fit the body of the connector around the core at the required position.
6. Hand tighten the main piercing bolt just enough to grip the core. This will stabilise the connector on the core.
7. Mark and cut the service core to length, remove 20mm of core insulation and insert the core 25mm deep into the service cable port. Fit the approved insulated holding tool over the body and tighten the clamping screws in the service take off ports with a 3mm insulated Allen key. Fit one of the red caps supplied over the clamping screw port. Repeat for the second service core if required.
8. With the holding tool still over the body of the connector, tighten the plastic head of the insulation piercing bolt until it shears off using an approved insulated 19mm socket. Disregard the sheared off head and fit the blanking plug (retained in stage 2) into the petal washer in the bolt entry port.

**NOTE: - When making neutral/earth connections the 35mm<sup>2</sup> copper PVC sheathed conductor will require incorporating into the connector.**

### Changing the Piercing Bolt

The procedure for changing the bolt is as follows:

1. Separate the two halves of the connector (see Fig.1)
2. Turn the upper half of the connector over, so that the brass insulation piercing bolt can be seen (see Fig.2).
3. Turn the 19 A/F drive key clockwise, until the bolt disengages from the thread of the aluminium top insert. Discard the bolt.
4. Take the special bolt, and, ensuring that the slotted end is towards you, insert the bolt, plain end first into the top insert. Screw in the bolt carefully, ensuring that the hexagon drive key engages. Take care not to allow the drive key to be forced upwards as this will damage the plastic insulation!
5. As soon as the drive key is engaged, rotate the drive key anti-clockwise until the slotted end of the bolt is flush with the surface of the plastic insulation (see Fig.3).
6. The connector is now ready for use.

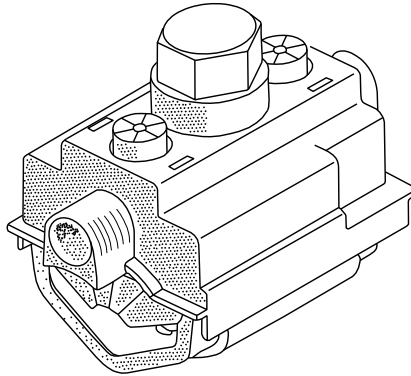


Fig 1

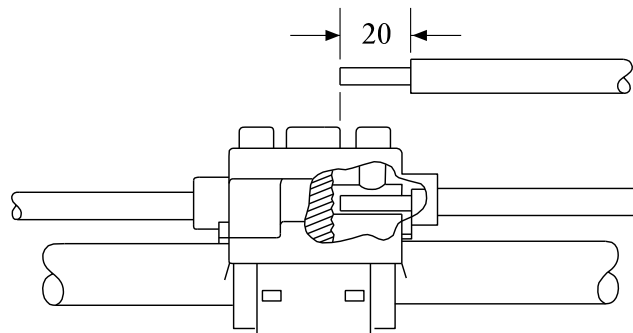
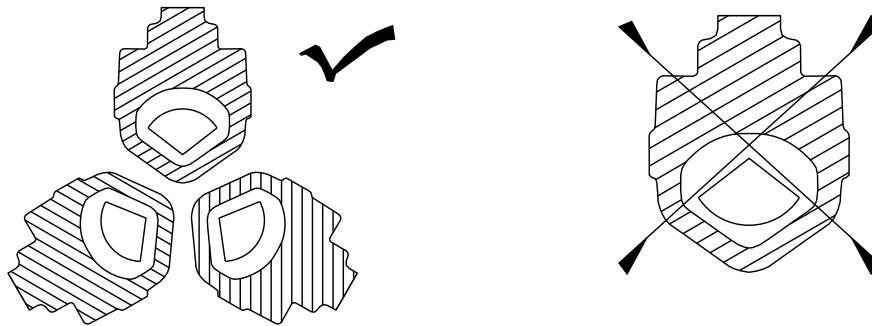
Fig 2


Fig 3

All dimensions in mm



Connector Setup For Three Or Four Core Stranded Or Solid Mains Cable



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## **BCNE CONNECTOR (Neutral/Earth and Earth Connections)**

These connectors are to be used in all mains straight, branch, service and stop ends on copper and aluminium stranded neutral/earth and earth wires up to maximum cross section for which the connector is designed.

The connector is a BCNE-3 and has a range taking sheer bolt to cover - 240mm<sup>2</sup> conductors.

Tooling - the BCNE-3 requires a 13mm socket which may be attached to a power driven tool or a ratchet spanner, the connector is held stable whilst shearing with a holding tool.

All tooling used is to fully insulated and company approved.

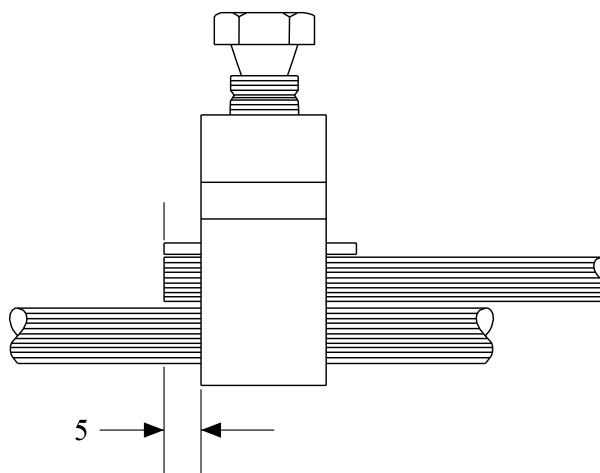
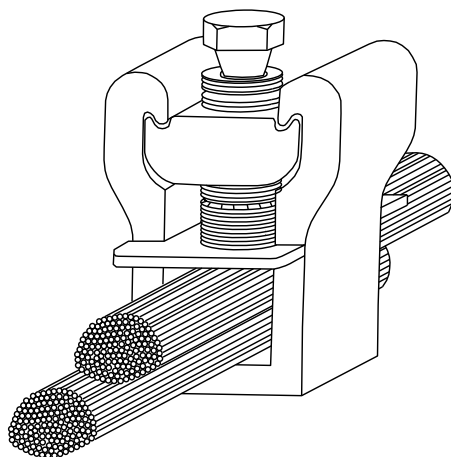
### **Connector Installation (BCNE) - Drawing GRD 6.29.12**


1. Cut the neutral/earth or earth wires 15mm beyond the connector centre line.
2. Position the neutral/earth or earth wires to be connected such that they overlay one on top of the other.
3. Position the main body of the connector around the conductors and slide the bridge into place.
4. Ensure the connector is correctly positioned and aligned. Hold the connector firmly with the holding tool and fully tighten the bolt until the head shears.

**NOTE: - The majority of connection's will require the inclusion of a tinned copper braid equalisation bond and copper earth tail.**

All dimensions in mm

### BCNE Connector



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## **TA CONNECTOR (Neutral/Earth Connections)**

These connectors are to be used in mains straight, branch, service and stop end joints on the aluminium neutral/earth sheaths of Consac cables, and allow for the connection of copper neutral/earth wires of mains and service cables.

There are three connectors in the range and are of shear bolt design which range take across specific conductor sizes as follows: -

TA1 covers 16 - 70mm<sup>2</sup> Cu conductor

TA2 covers 16 - 120mm<sup>2</sup> Cu conductor

TA3 covers 16 - 70mm<sup>2</sup> Cu conductor (service/cu earth tail connections only)

Brass gauze is used to wrap copper conductors.

Tooling - the TA connector requires a 13mm socket which is attached a ratchet spanner, the connector is held stable whilst shearing with a holding tool.

Power driven tooling is **not to be used** with this connector.

All tooling used is to be fully insulated and company approved.

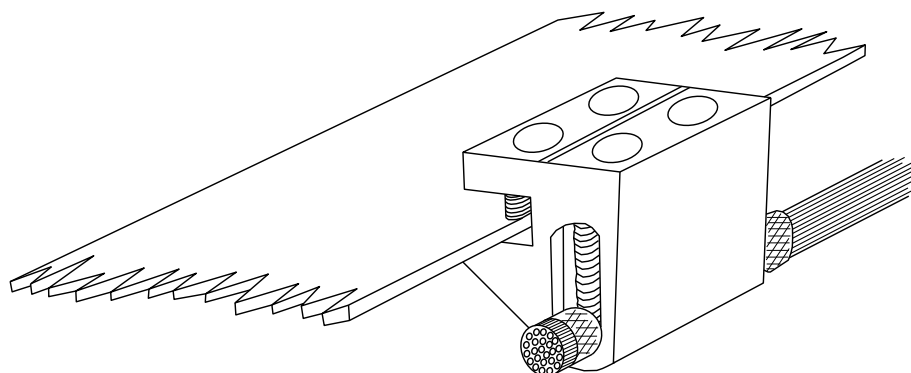
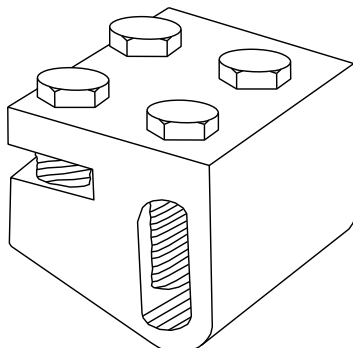
### **Connector Installation (TA) - Drawing GRD 6.29.13**

1. Clean and abrade the aluminium neutral/earth sheath at the connector position.
2. Position the connector on the aluminium sheath and finger tighten the bolts.
3. Cut the copper wires 5mm beyond the connector and wrap the copper wires with brass gauze.
4. Remove the connector and insert the copper wires and finger tighten the bolts.
5. Tighten the brass bolts evenly until they shear.
6. Position the connector back onto the aluminium sheath, ensuring the connector is held tight to the sheath edge, tighten the aluminium bolts evenly until they shear.


**NOTE: - A copper earth tail may be connected in place of the copper neutral/earth wires.**

All dimensions in mm

TA Connector



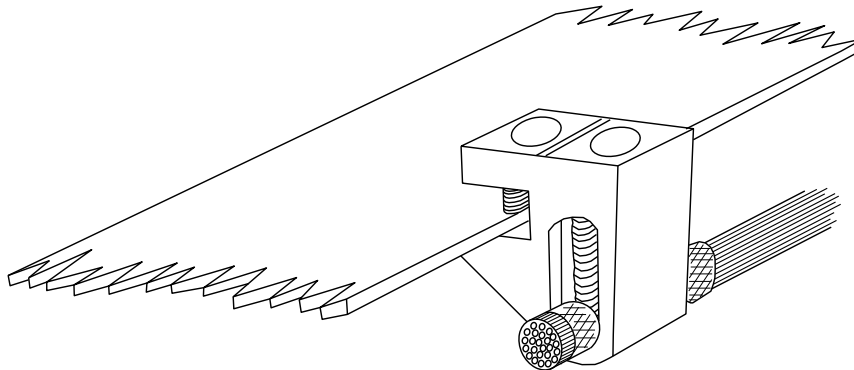
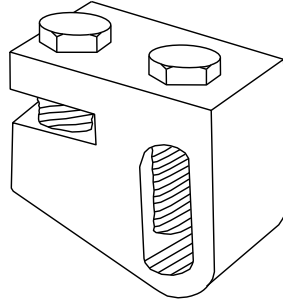
Copper Stranded Conductors Are To Be Wrapped With Brass Gauze

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All dimensions in mm

TA Connector



Copper Stranded Conductors Are To Be Wrapped With Brass Gauze

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## **LVET CONNECTORS (Phase and Neutral Connections)**

These connectors are to be used on all mains end terminations for solid aluminium 90° and 120° sector shaped conductors up to the maximum cross section for which the connector is designed.

Each connector palm is drilled with a M12 clearance hole.

There are three connectors in the range and are of shear bolt design which range across specific conductor sizes as follows: -

LVET 120-12 covers 95mm<sup>2</sup> Al conductor

LVET 185-12 covers 185mm<sup>2</sup> Al conductor

LVET 300-12 covers 300mm<sup>2</sup> Al conductor

Tooling - the LVET 120 requires a 13mm socket and the LVET 185 and LVET 300 requires a 19mm socket which may be either a power driven tool or ratchet spanner, the connector is to be held stable whilst shearing with a adjustable holding tool.

All tooling used on these connectors must be approved and insulated.

### **Connector Installation (LVET) - Drawing GRD 6.29.15**

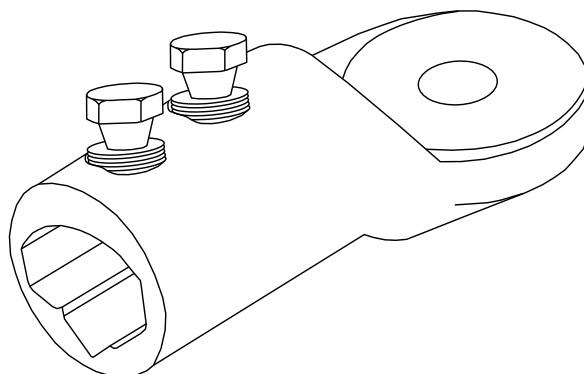
These connectors are for **dead working** only.

1. Cut the core so that it will occupy the full depth of the connector barrel.
2. Remove the insulation from the conductor to a position the depth of the barrel plus 5mm.
3. Use an approved insulated core twisting tools to align conductors if required.
4. Using an approved insulated file card abrade the aluminium conductor.
5. Insert the conductor into the connector and finger tighten the bolts.
6. Holding the connector with a holding tool tighten the bolts evenly until they shear.
7. Using an approved insulated file card abrade the palm of the contact face of the connector.
8. Smear the abraded palm face with approved electrical contact grease and connect to the termination point.

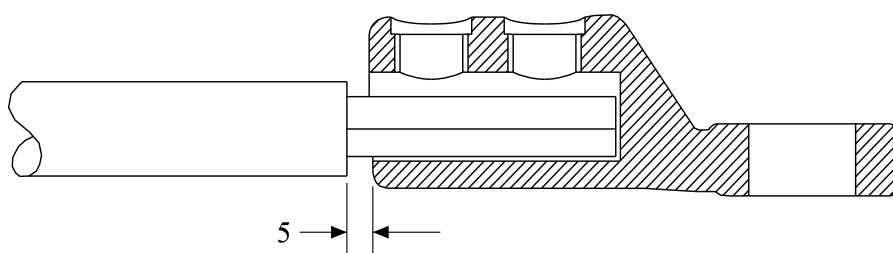
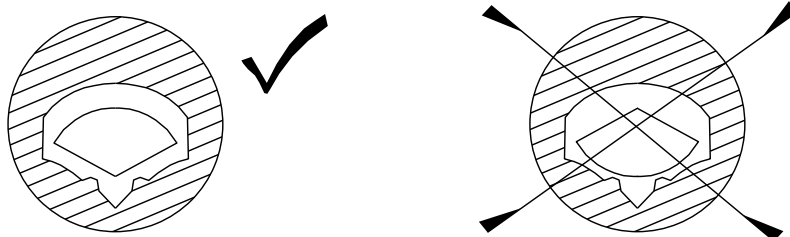


All dimensions in mm


### LVET Connector



### Conductor Setup Within Connector



Connector Is To Be Used On Solid Aluminium Conductors Only

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## **BET CONNECTORS (Neutral/Earth and Earth Connections)**

These connectors are to be used on all mains end terminations for stranded copper conductors up to the maximum cross section for which the connector is designed.

Each connector plan is drilled with a M12 clearance hole.

There are two connectors in the range and are of shear bolt design and range take across specific conductor sizes as follows: -

BET 60-12 covers 60mm<sup>2</sup> Cu conductors

BET 120-12 covers 120mm<sup>2</sup> Cu conductor

Tooling - the BET 60 requires a 13mm socket and the BET 120 requires a 16mm socket which may be either a power driven tool or hand ratchet spanner, the connector is to be held stable whilst shearing with a adjustable holding tool.

All tooling used on these connectors must be approved and insulated.

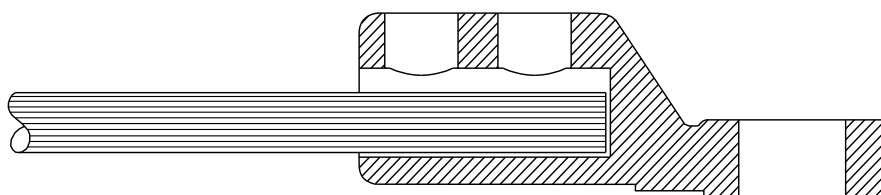
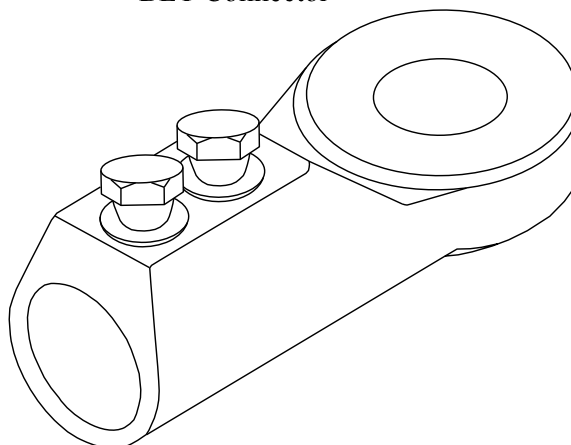
### **Connector Installation (BET) - Drawing GRD 6.29.16**

These connectors are for **dead working** only.


1. Cut the copper wire conductor so that it will occupy the full depth of the connector barrel.
2. Insert the conductor into the connector and finger tighten the bolts.
3. Holding the connector with a holding tool tighten the bolts evenly until they shear.
4. Connect the connector to the termination point.

All dimensions in mm

**BET Connector**



**Connector Is To Be Used On Stranded Copper Conductors Only**

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## **ML CONNECTORS (Phase and Neutral Connections)**

These connectors are to be used on all single core mains terminations for round solid aluminium and stranded copper conductors up to the maximum cross section for which the connector is designed.

Each connector is blank palm and marked for single or four bolt fixing.

There are two connectors in the range and of shear bolt design which range across specific conductor sizes as follows:-

ML 7 covers 480-630mm<sup>2</sup> conductors

ML 8 covers 740-960mm<sup>2</sup> conductors

Brass gauge is to be used to wrap copper conductors.

Tooling - the ML connector requires a 19mm socket which may be attached to either a power driven tool or hand ratchet spanner.

All tooling is to be insulated and Company approved.

### **Connector Installation (ML) - Drawing GRD 6.29.17**

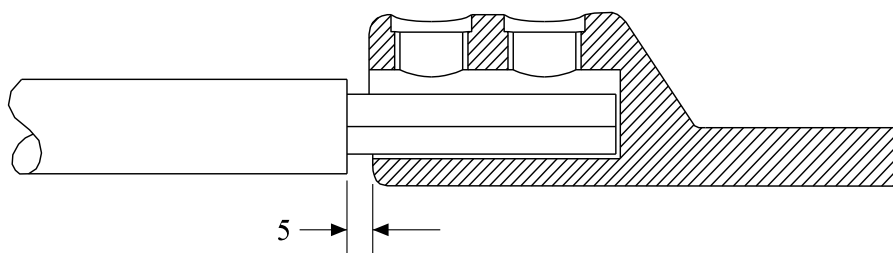
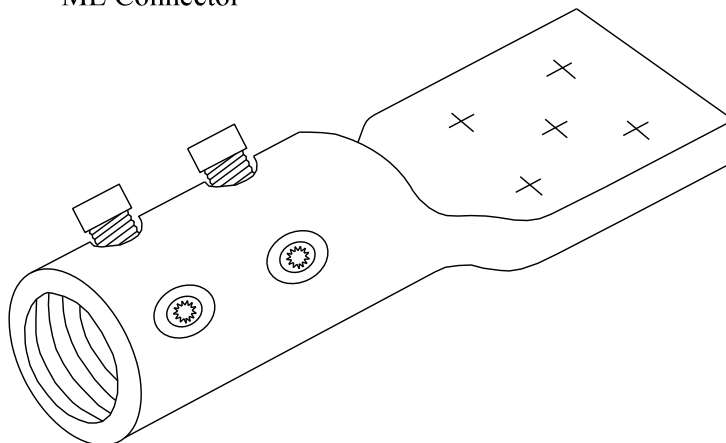
These connectors are for **dead working** only.

1. Cut the core so that it will occupy the full length of the connector barrel.
2. Remove the insulation from the conductor to a position the depth of the barrel plus 5mm.
3. Degrease the conductor if necessary.
4. Using an approved insulated file card abrade any aluminium conductor.
5. Insert the conductor into the connector and finger tighten the bolts.
6. Support the connector and tighten the bolts evenly until they shear.
7. Apply heatshrink tube insulation to the dimensions given in the Jointing Procedure.
8. Smear the palm face with an approved electrical contact grease and connect to the termination point.


**Do not abrade the lug palm.**

All dimensions in mm

ML Connector



Copper Conductors Are To Be Wrapped With Brass Gauze

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SCALE	N.T.S.		Title INSTALLATION OF ML CONNECTOR - SINGLE CORE INDOOR TERMINATIONS			Drg. No. GRD 6.29.17
						Rev No

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## **UT CONNECTOR (Phase and Neutral Connections)**

These connectors are to be used in the Heavy Duty cut-outs and the two and four way Link Disconnection Box.

They are for use on solid aluminium 90° and 120° sector shaped conductor up to the maximum cross section for which the connector is designed.

The connector is of shear bolt design which range across specific conductor sizes as follows:-

UT3 covers 95 - 300mm<sup>2</sup> conductor

Tooling - the UT3 requires a 17mm socket which may be attached to either a power driven tool or hand ratchet spanner.

All tooling used on these connectors must be approved and insulated.

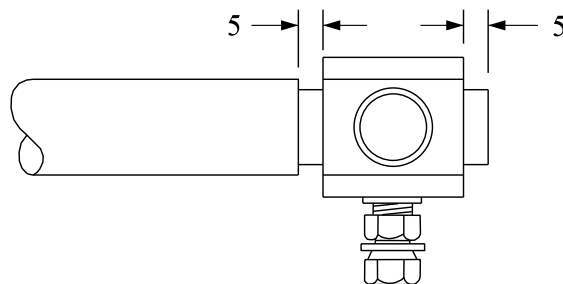
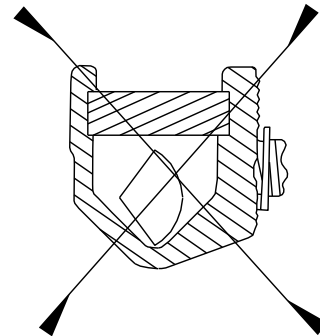
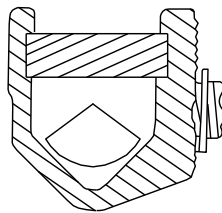
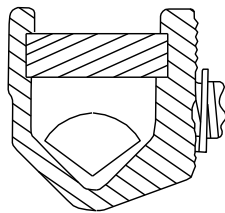
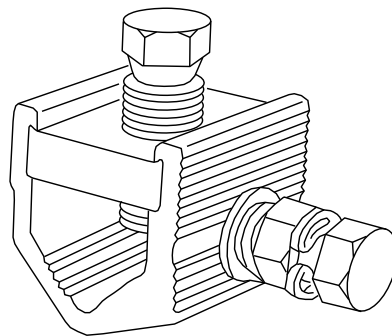
### **Connector Installation (UT) - Drawing GRD 6.29.18**

These connectors are for **dead working** only.

1. Cut the core so that it will occupy the connector length plus 5mm overlap.
2. Remove the insulation from the conductor to a position of the connector length plus 10mm.
3. Use an approved insulated core twisting tools to align the conductor if required.
4. Using an approved insulated file card abrade the conductors.
5. Insert the conductor into the connector, slide the bridge into place and finger tighten the bolt.
6. Supporting the conductor tighten the bolt until it shears.

All dimensions in mm

UT Connector



Connector Is To Be Used On Solid Aluminium Conductors Only

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## **UT CONNECTOR (Neutral/Earth Connections)**

These connectors are to be used in two and four way Link Disconnection Boxes. They are for use on stranded copper conductors up to the maximum cross section for which the connector is designed.

The connector is of shear bolt design and range takes across specific conductor sizes as follows:-

UT13 covers 140 - 240mm<sup>2</sup> conductors

Tooling - the UT13 requires a 13mm socket which may be attached to either a power driven tool or hand ratchet spanner.

All tooling used on these connectors must be approved and insulated.

### **Connector Installation (UT) - Drawing RD 6.29.19**

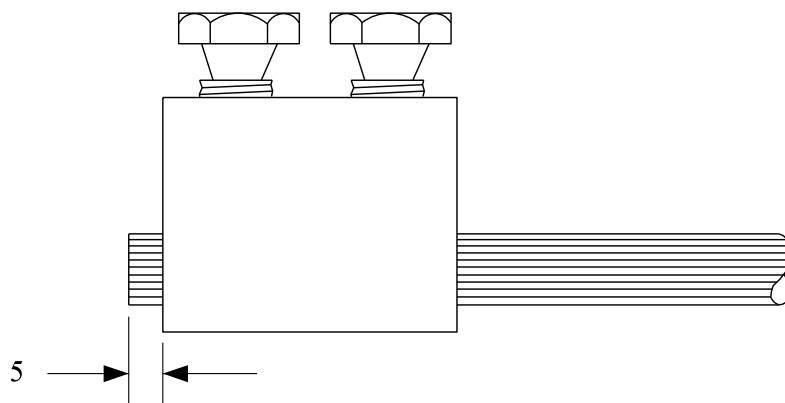
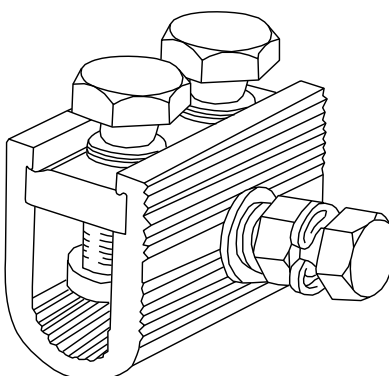
These connectors are for **dead working** only.

1. Cut the copper wire conductor so that it will occupy the length of the connector plus 5mm.
2. Insert the conductor into the connector, slide the bridge into place and finger tighten the bolts.
3. Supporting the conductor tighten the bolts evenly until they shear.




All dimensions in mm

UT Connector



Connector Is To Be Used On Stranded Copper Conductors Only

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Drawn	RJB	06/12			
Checked				Title <div>INSTALLATION OF UT</div> <div>CONNECTOR - LDB TERMINATIONS</div> <div>Drg. No.</div> <div>GRD 6.29.19</div> <div>Rev No</div>	
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## **HVBSTM CONNECTORS (Phase and Neutral Connectors)**

These connectors are for use on three and four core Wavecon outdoor overhead terminations, they will accommodate solid aluminium 90° and 120° sectors shaped and stranded copper conductors at the appropriate end of the connector, up to the maximum cross section for which they are designed.

There are three connectors in the range and are of shear bolt design, they are unique to one conductor size only as follows:-

HVBSTM 14SO UTB covers 95mm<sup>2</sup> Wavecon - 70mm<sup>2</sup> Copper PVC Sheathed  
HVBSTM 2124SO UTB covers 185mm<sup>2</sup> Wavecon - 120mm<sup>2</sup> Copper PVC Sheathed  
HVBSTM 2130SO UTB covers 300mm<sup>2</sup> Wavecon - 120mm<sup>2</sup> Copper PVC Sheathed

Tooling - the HVBSTM 14SO UTB requires a 15mm socket and the HVBSTM 2124SO UTB and HVBSTM 2130SO UTB requires a 19mm socket; which may be attached to either a power driven tool or hand ratchet spanner. The connector is held stable whilst shearing with a adjustable holding tool.

### **Connector Installation (HVBSTM) - Drawing GRD 6.29.20**

These connectors are for **dead connections** only however only approved insulated tooling will be used.

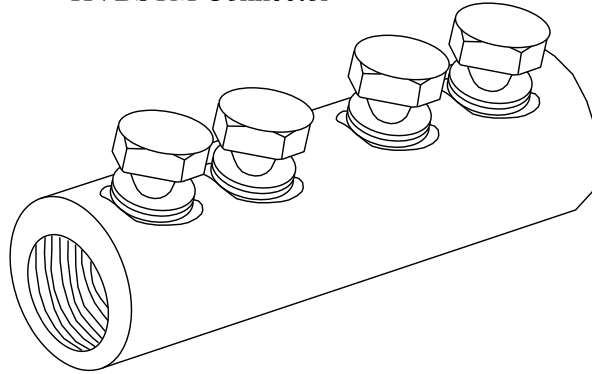
### **Wavecon Conductors**

1. Remove the insulation from the conductor to a position the depth of the barrel plus 5mm.
2. Using an approved insulated file card abrade the aluminium conductors.
3. Install the connectors on the conductor and finger tighten.

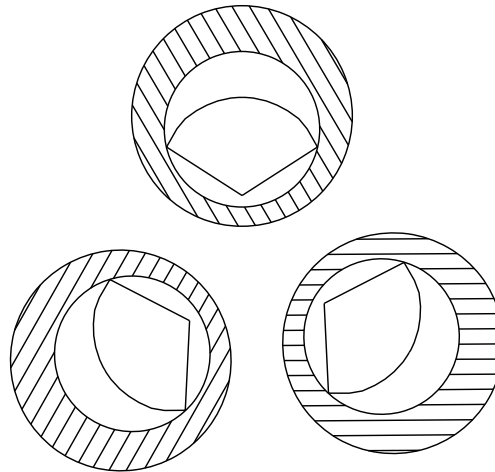
### **PVC Sheathed Copper Conductor.**


4. Cut the conductor to the required length.
5. Remove the insulation from the conductor to a position the depth of the barrel plus 5mm.
6. Insert the conductors into the connector and finger tighten the bolts.
7. Holding the connector with an approved insulated holding tool tighten the bolts evenly until they shear.

### HVBSTM Connector



### Connector Setup For Three And Four Core Wavecon Cables

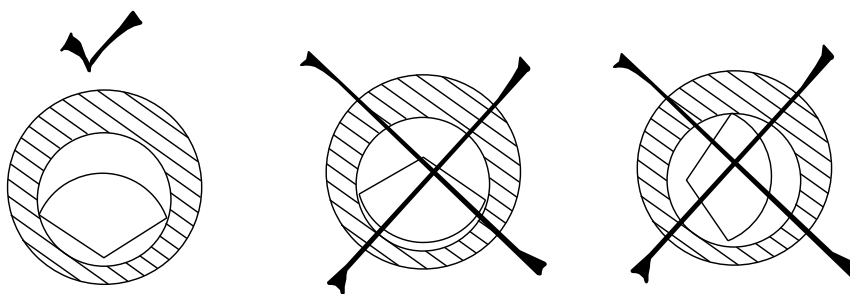


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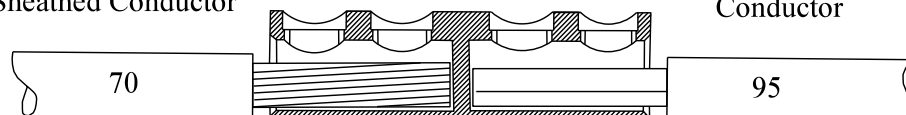
All dimensions in mm

# Conductor Set-Up Within Connector

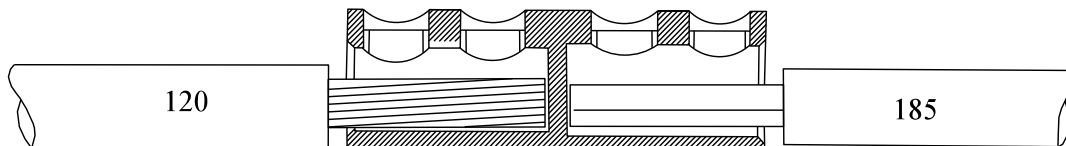


Copper PVC  
Sheathed Conductor

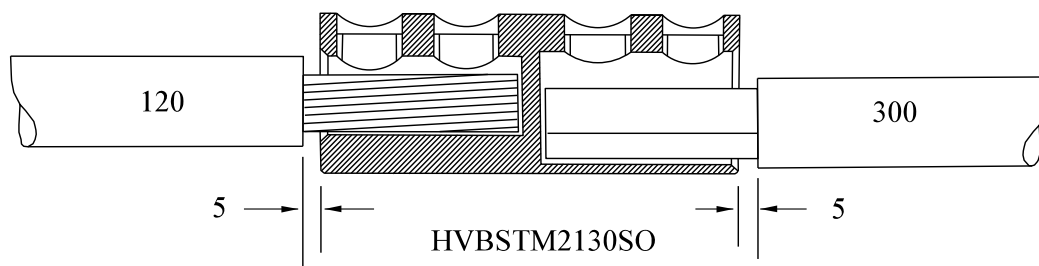
Wavecon  
Conductor




HVBSTM14SO



HVBSTM2124SO



HVBSTM2130SO

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## **GENERAL REQUIREMENT 30**

### **APPLICATION OF INSULATION SHROUDS FOR MECHANICAL CONNECTORS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

For the UST, UST TI with service connection, UBR and BTC connectors the manufacturer supplies bespoke plastic, orange coloured shrouds with each of the above connectors, the base of the connector comes pre-loaded with the base orange shroud the conductors are inserted into the connector and the bolts sheared off, the top half of the orange shroud are “snapped” over the relevant connector thus insulating the said connector.

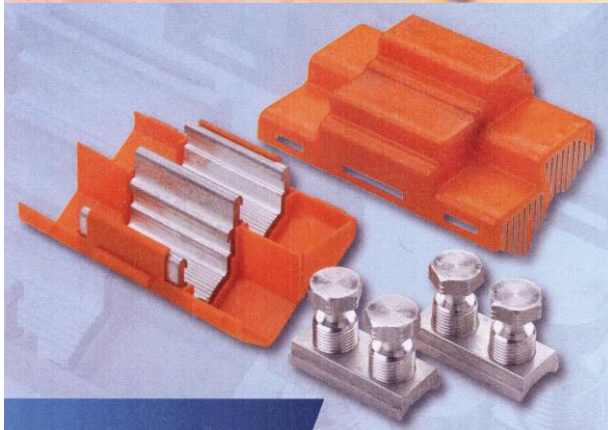
See photographs below.



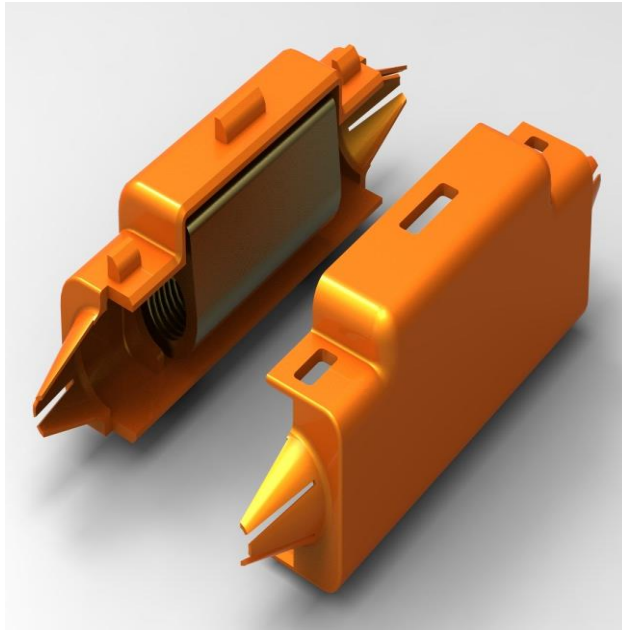
UST Connector complete with orange shrouding.



UST with Top Insert Connector complete with orange shrouding.



UBR Connector complete with orange shrouding.



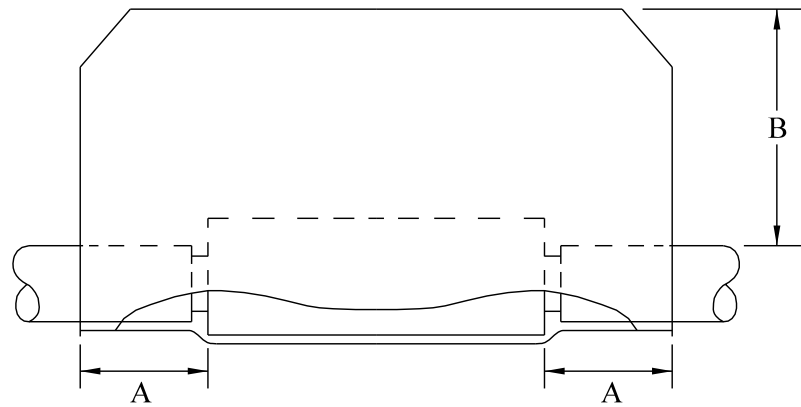
BTC Brass Tunnel connector complete with orange shrouding.

If bespoke shrouds are not supplied with the connector then the following applies: -

The insulation shrouds used on mechanical connectors are patches of adhesive backed rubber material. The rubber is supplied in rolls 230mm wide and 7.3m long. Individual shrouds will be made by cutting patches from the roll.

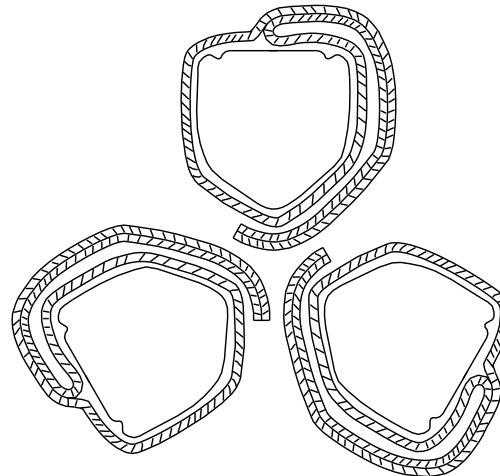
1. Prepare the insulation shroud by passing the material around the connector to achieve an overlap. Trim to the required length – Drawing GRD 6.30.1.
2. Remove the protective backing and apply the insulation around the connector. Ensure that the ends and sides of the shroud are pinched together to avoid accidental contact with live conductors.
3. Trim off any excess rubber with scissors. If necessary, to ensure clearance from the joint shell, cable tie(s) may be applied around the **body** of the insulated connector.

All dimensions in mm




'A' Dimension = 60 Min For Mains Connectors  
= 35 Min For Service Connectors

'B' Dimension = Sufficient Length Allowed To Wrap  
Between Conductors



**NOTE:-** Cable Ties Are Not To Be Overtightened Around  
The Rubber Insulation At The Connector Ends

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				APPLICATION OF INSULATION SHROUDS	
				Drg. No. GRD 6.30.1	
				Rev No	

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## **GENERAL REQUIREMENT 31**

### **FORMING CONSAC SHEATH INTO THE FINAL POSITION**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

**Note:** - If the Consac sheath is to be bent at both ends of the joint, these instructions must be carried out simultaneously at both ends.

1. Use a clean 150mm length of surplus Consac or Wavecon oversheath, ensuring it is thoroughly degreased.
2. Position the piece of oversheath to protect the paper insulation across the full width of the aluminium sheath, taking care to ensure protection of the core paper within the belt paper termination area.
3. Carefully bend the aluminium sheath into position, ensuring that there is adequate clearance between the sheath and other parts of the joint.
4. The piece of PVC oversheath may be left in position to provide continuing protection against abrasion of the papers by the aluminium.



## GENERAL REQUIREMENT 32

### ABRADING PVC OVERSHEATHS

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

The abrading of PVC oversheaths must be carried out diligently because the adherence of the resin depends upon it. It must be remembered that this produces the primary moisture seal and if this is not effective the joint will surely fail.

All PVC sheaths within the joint shell shall be abraded (a minimum distance of 50mm)

1. At the position at which the abrading is to be carried out thoroughly clean the oversheath with an approved degreaser to remove all contaminants.
2. Thoroughly and circumferentially abrade the cleaned surface of the sheath with: -
  - (a) Mains cable – a rasp.

A rough matt finish is required and **all** embossing and glaze is removed. Check the underside of the cable with a mirror.

3. Clean the abraded area with the approved degreaser to remove all loose particles.

## **GENERAL REQUIREMENT 33**

### **MASTIC WATER BLOCK FOR LEAD SHEATHS AND COPPER EARTH TAILS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

Polyurethane resin will not form an effective seal to the lead sheath or copper earth tail by itself, therefore it is necessary to introduce a mastic tape seal.

When the bonding of the armour and earth conductor has been completed in accordance with General Requirement 22/23, there should be a minimum 40mm gap between the bonds.

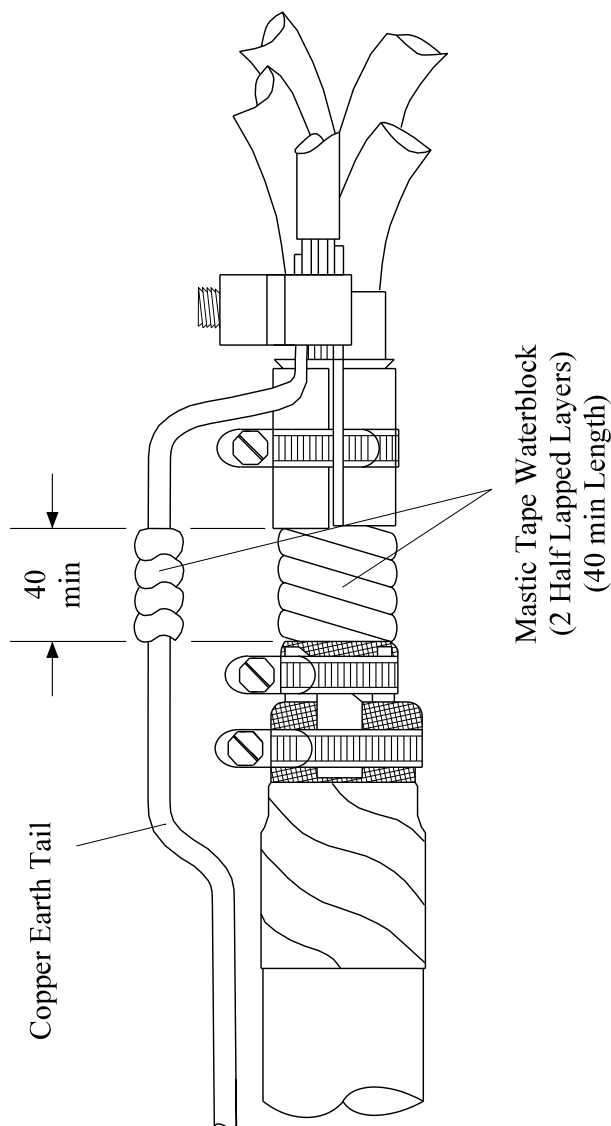
#### **33.1 Lead Sheaths**

1. Thoroughly clean the exposed lead sheath between the two bonds with the approved degreaser - General Requirement 35.
2. Abrade circumferentially the whole area with an approved insulated file card.
3. Clean the abraded sheath with the approved degreaser.
4. Apply with light tension two half lap layers of the Boddingtons mastic tape over a minimum length of 40mm

#### **33.2 Copper Earth Tail**


1. Thoroughly clean the copper earth tail at the position the water block is to be applied with the approved degreaser - General Requirement 35.
2. Apply with light tension two half lap layers of the Boddingtons Mastic Tape over a minimum length of 40mm.

All dimensions in mm



PLAN VIEW

NOTE:- The Copper Earth Tail Is Omitted In Service Joints

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Checked			Title <b>MASTIC WATERBLOCK FOR LEAD SHEATH AND COPPER EARTH TAIL GENERAL LAYOUT</b>			Drg. No. <b>GRD 6.33.1</b>
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## **GENERAL REQUIREMENT 34**

### **INSTALLATION OF EARTH ELECTRODE AND EARTH RODS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

The earthing conductor shall be a solid Cu. conductor which is equivalent of 20mm<sup>2</sup> copper earth tail.

#### **34.1 Installation of Earth Electrodes**

1. A 5mm diameter solid copper earth electrode must be installed in all mains joints. Once connected the electrode should be loosely coiled under the joint.
2. The earth electrode is supplied with a flat end that is designed to fit the BCNE connectors within the joints.

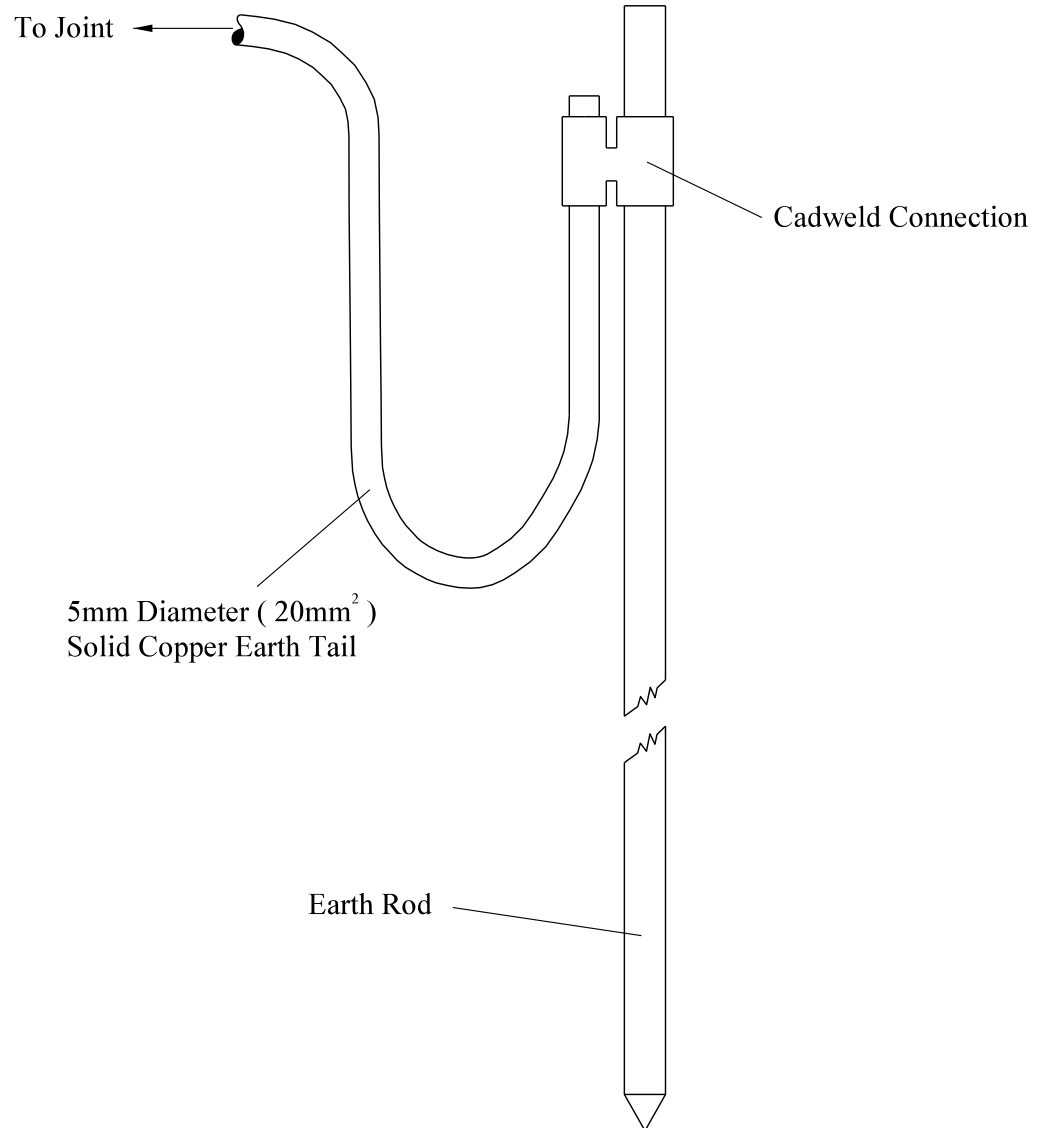
#### **34.2 Installation of earth rods**

1. Before knocking in any earth rods, cable locators and plans must be used to ensure that there is no underground equipment that could be damaged. Where doubt exists excavations should be made to check for underground equipment.
2. Inspect the earth rod to make sure that it is straight and undamaged.
3. Fit a driving cap to the end of the rod to prevent unnecessary damage.
4. Drive the rod into the ground until the driving head is approximately 350mm below the surface.
5. In the majority of situations it is possible to drive the rod with a lump / sledge hammer. In difficult conditions mechanical means may be adopted.
6. Remove the driving cap.

#### **34.3 Connection To Earth Rods**

Earth electrodes (below ground) must only be connected using the Cadweld system. Mechanical connections below ground are no longer Approved. For details please see ST:TP21-1.

All dimensions in mm



1	RJB			09/13	CONNECTOR CHANGED
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				WESTERN POWER DISTRIBUTION Design Department. Avonbank, Feeder Road, Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	
				Title INSTALLATION OF EARTH ELECTRODE AND EARTH CONDUCTOR	
				Drg. No. GRD 6.34.1	Rev No 1

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## **GENERAL REQUIREMENT 35**

### **DEGREASING OF JOINTS BEFORE ENCAPSULATION**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

Before resin encapsulation takes place it is important to thoroughly degrease the complete joint to ensure a good seal and prevent the ingress of moisture.

The degreasing operation must be carried out prior to the fitting of the outer box and after all outer sheath abrading and aluminium sheath setting has been completed.

1. Apply the degreaser to a clean white wipe, only use sufficient to effectively remove any contaminant present.
2. Firstly degrease any metal sheaths, earths and neutral/earth connections. Change the wipe as it becomes contaminated.
3. Degrease any abraded PVC sheaths.
4. When degreasing has been completed, replace the top on the container to avoid spillage.

## **GENERAL REQUIREMENT 36**

### **FITTING OF SHELLS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

#### **36.1 Build up cables to match shell entries**

The build up of the black cotton tape used for sealing the ends of the shells must be adequate to prevent leakage of resin.

When more than one cable is in one entry (e.g. service cables) each must be built up separately and kept out of contact with each other so that the resin may flow around both cables. This is essential since if the cables are touching moisture will travel up the interface. Joint failures have occurred in the past due to this defect.

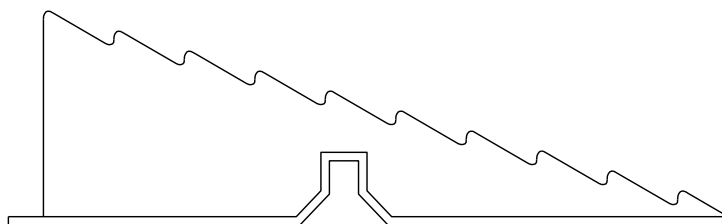
1. Build up the cable(s) with black cotton adhesive tape to match the cable entries of the joint shell. Ensure the effectiveness of this build up to prevent any leakage of resin.

#### **36.2 Fitting of joint shells – Drawing GRD 6.36.1**

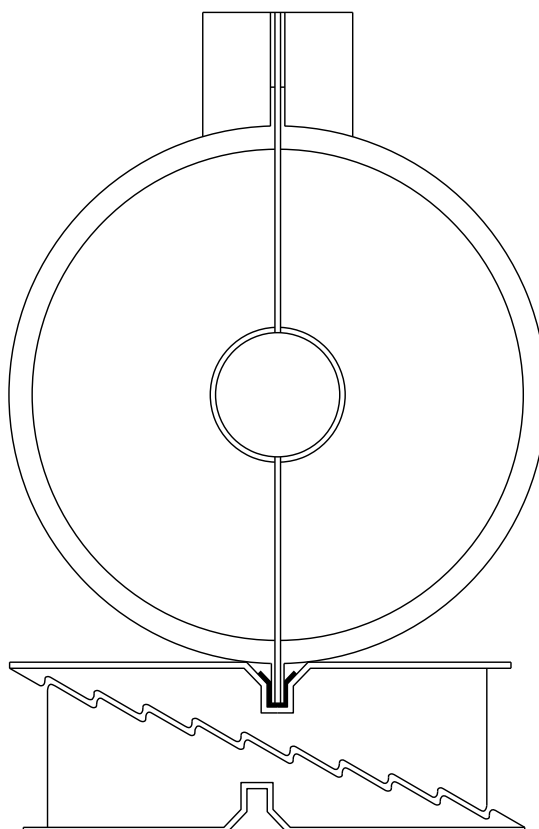
In resin-filled joints the shell serves the purpose of containing the resin while it is in liquid form. It is therefore essential that the shell is carefully fitted, adequately sealed and supported to prevent any leakage of resin.


1. Clean and dry the inside of the shell.
2. Temporarily position the shell and ensure that there is a minimum of 15mm clearance between all parts of the joint and the shell.
3. Position the shell over the joint.
4. Fit the clips. Make sure that one clip is put between each of the cable double entries.
5. Seal the outside of the cable entries with sealing putty.
6. Support the shell and cables to prevent any sag when the resin is poured into the joint shell.

All dimensions in mm



Joint Support



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## **GENERAL REQUIREMENT 37**

### **MIXING AND POURING THREE PART POLYURETHANE RESIN**

#### **WT HENLEY or PRYSMIAN THREE PART RESIN**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

#### **37.1 General**

The liquid components of the three-part polyurethane resin currently used in cable joints, within the Company, is contained in a foil pack which forms an enclosed system. This means that mixing of the polyol and hardener components is completed before possible exposure.

Although the enclosed system should be effective in preventing contact with harmful materials, the following basic precautions shall be taken when using three-part polyurethane resin.

#### **37.2 Safety Precautions**

##### **Skin Contact**

The hardener is irritating to the skin. The use of the disposable plastic gloves provided should eliminate any contact, but if it occurs, the affected area should be washed immediately with plenty of soap and water.

##### **Splashes in the eye**

The hardener is irritating to the eyes. Suitable protection such as goggles or a face visor shall be worn when pouring or stirring. In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.

##### **Breathing of vapour**

Ensure that adequate ventilation is provided to prevent high concentrations of vapour building up in the working area. Pay particular attention to this requirement when working in confined areas.

##### **Fire hazard**

The resin and hardener have low flammability, but if a fire occurs in an area where the hardener is stored, a dangerous vapour will be produced. Anyone tackling the fire must wear suitable respiratory equipment.

##### **Topping up of Joints**

When using multiple buckets of resin for the various joints the maximum time between pouring one bucket of resin to the next bucket of resin is ten (10) minutes.

## Decontamination of containers

Isocyanate containers must be neutralised before disposal. This can be done by filling the container with water and leaving with the top off for 24 hours. The top should not be replaced, so that the carbon dioxide gas produced by escape, otherwise the container may burst.

**This is unnecessary with the foil pack. The packet can be disposed of as non harmful after the contents have been mixed, provided the WPD label WPD/W400121 is stuck over the relevant DSD or CLP warning labels.**

### 37.3 Mixing WT Henley or Prysmian Resin

General information and mixing instructions for the WT Henley or Prysmian three-part polyurethane resin are as follows:-

Suitable protective clothing, as per the matrix given General Requirement 3 shall be worn while mixing and pouring the resin.

Safety and handling information is printed on the outside of the pack.

- 3.1. Remove the pouch containing the resin and hardener from the sand. Remove the bag of sand from the bucket.
- 3.2. Ensure PPE as per the matrix in General Requirement 3 are worn.
- 3.3. Examine the foil pouch containing the hardener and polyol are not damaged in anyway. Once the inspection has been completed, support the pouch in the upright position on a convenient surface with the polyol (larger side) closer to you. Grip both sides of the pouch between the fingers and ball of the thumb. Gently tease the centre seal apart. Once the seal has broken, gently pull the sides of the pouch apart for the remainder of the seal.
- 3.4. Knead the sachet pack contents thoroughly for two minutes, taking care not to damage the sachet.
- 3.5. Cut a corner of the sachet, and pour into the empty bucket, rolling up the sachet and squeezing will aid removal of the resin mixture.
- 3.6. Gradually add the sand to the bucket while stirring the contents of bucket until it is thoroughly and evenly dispersed.
- 3.7. Pour the mix slowly into the joint shell. If more than one resin mix is required to fill the joint shell, subsequent mixing should be continuous so that delays are kept to a minimum.
- 3.8. Apply a WPD non harmful warning label over all manufacturers' harmful warning labels - GRD 6.37.1.
- 3.9. The used sachet pack, mixing bucket etc. can be disposed of as non toxic industrial site waste, after mixing.

## **37.4 TYCO THREE PART RESIN**

### **Mixing Tyco Resin**

Safety and handling information is printed on the outside of the pack and must be observed.

- 4.1 Examine the foil pouch containing the hardener and polyol to ensure it is free of damage.
- 4.2 Support the foil pouch and using scissors make a small cut to the bag top, carefully tear the top edge along its length starting at the cut position.
- 4.3 Remove the contents from the foil pouch checking the two compartments for damage.
- 4.4 Support the two components with the green channel uppermost, take the free end of the bag and pull gently this will release the green channel and slide rail.
- 4.5 With the bag extended to its full length and with a tumbling action allow the two components to mix thoroughly until a uniform colour is achieved.
- 4.6 Mixing thoroughly for two minutes ensuring all components are removed from the seams of the bag.
- 4.7 Cut a corner of the sachet, and pour into the empty bucket, rolling up the sachet and squeezing will aid removal of the resin mixture.
- 4.8 Gradually add the sand to the bucket while stirring the contents of bucket until it is thoroughly and evenly dispersed.
- 4.9 Pour the mix slowly into the joint shell. If more than one resin mix is required to fill the joint shell, subsequent mixing should be continuous so that delays are kept to a minimum.
- 4.10 Apply decontamination labels to all hazardous warning signs and remove to WPD depots for correct disposal, drawing GRD 6.37.1.

All dimensions in mm

Adhesive Backed Label


**WESTERN POWER**   
**DISTRIBUTION**

*Serving the Midlands, South West and Wales*

THE CONTENTS OF THIS PACKAGE  
HAVE BEEN RENDERED INERT AND  
ARE NO LONGER HARMFUL

Note :- This Label Is To Be Placed Across The Black  
Warning Cross On The Orange Background  
Of The Suppliers Harmful Warning Label

This Is To Be Undertaken On All Harmful Substance  
Containers / Packaging Used Within WPD  
Once The Substance Has Been Rendered Inert

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Drawn	RJB	06/12				
Checked						
Approved						
SCALE	N.T.S.		Title DECONTAMINATION LABEL FOR HARMFUL SUBSTANCE CONTAINERS / PACKAGING			Drg. No. GRD 6.37.1
						Rev No

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## GENERAL REQUIREMENT 38

### CRUTCH SEAL FOR SERVICE CABLES

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3.

A crutch seal must be applied to the end of a concentric service cable in cut-out terminations where the cut-out position is significantly lower than the service cable route.

The methods to be used for various cable types are detailed below.

#### 38.1 Single Phase Plain/Split Concentric Service Cable – Drawing GRD 6.38.1

1. Remove PVC sheath to the mark as required in the jointing instruction. General Requirement 6.
2. Unwrap and bend back the neutral/earth and or earth wires removing the PVC fillers – Fig 1. **Do not kink the wires at the PVC termination.**
3. Apply a 20mm long piece of “Scotchfil” putty tape to the phase core under light tension and press well down into the crutch – Fig 2.
4. Lay the neutral/earth wires back over the pad ensuring they are evenly spaced and not crossed – Fig 3.
5. Apply two layers of “Scotchfil” putty with light tension and using 25% overlap over the neutral/earth and or earth cores. Start just above the core seal and continue down to overlap the PVC sheath by 10mm – Fig 3.
6. Apply two layers of “88” black PVC tape over the seal with a 50% overlap and stretching the tape to compress the seal. Ensure that the PVC taping completely encloses the seal – Fig 3.

#### 38.2 Three Phase Plain/Split Concentric Service Cable – Drawing GRD 6.38.2

1. Remove the PVC sheath to the mark as required in the jointing procedure. General Requirement 6.
2. Unwrap and bend back the neutral/earth and or earth wires. **Do not kink the wires at the PVC termination.**
3. Apply a hemp binder to the polythene bedding tapes 10mm above the PVC sheath termination.
4. Remove the bedding and the PVC fillers back to the binder.

5. Cut three 20mm lengths of “Scotchfil” putty tape and press the mid points together to form a ‘Y’ piece of double thickness – Fig 1.
6. Separate the three phase cores and placing and pressing the ‘Y’ piece well down in between the cores – Fig 2.
7. Mould each end of the ‘Y’ piece around the cores – Fig 3.
8. Apply a 30mm piece of “Scotchfil” putty under tension over the core seal to provide a smooth surface for the neutral/earth and or earth wires. Overlap the bedding tapes by 10mm – Fig 4.
9. Lay the neutral/earth and or earth wires back over the pad ensuring they are evenly spaced and not crossed.
10. Apply two layers of 19mm “Scotchfil” putty with light tension and using 25% overlap over the neutral/earth and or earth wires. Start just above the core seal and continue down to overlap the PVC sheath by 10mm.
11. Apply two layers of ‘88’ black PVC over the seal with a 50% overlap and stretching the tape to compress the seal. Ensure that the PVC taping completely encloses the seal.

PVC Fillers To Be Cut  
Off At PVC Termination  
(Spilt Conc Cables Only)

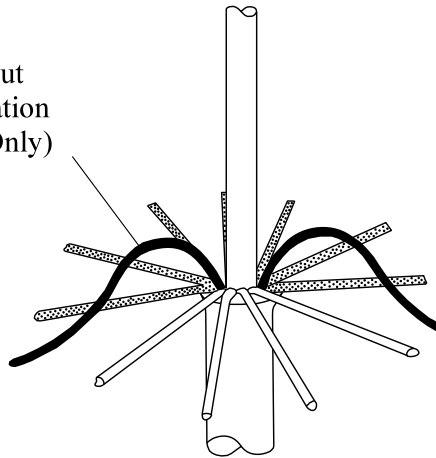


Fig 1

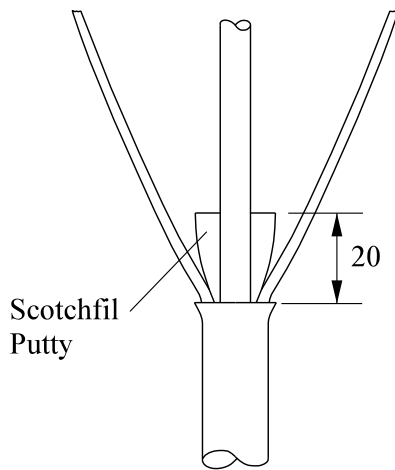


Fig 2

Two Layers Of  
'88' Black PVC  
Tape To Enclose  
This Seal

Scotchfil  
Putty

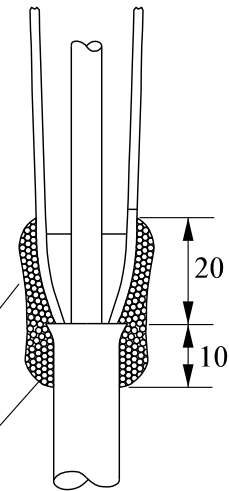

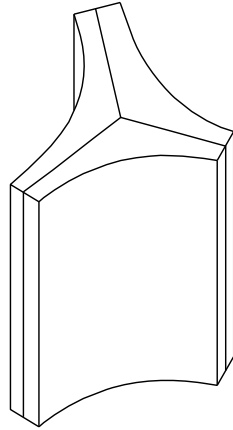


Fig 3

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Checked			CRUTCH SEAL FOR PVC CONCENTRIC SERVICE CABLE - SINGLE PHASE			
Approved			Drg. No. GRD 6.38.1			
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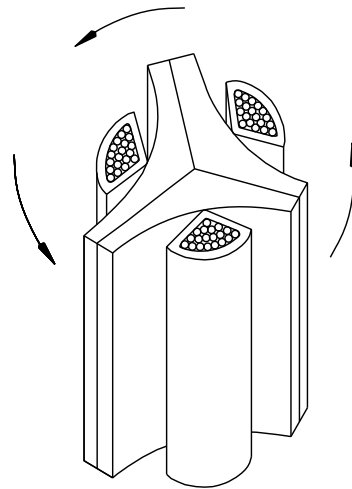
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All dimensions in mm



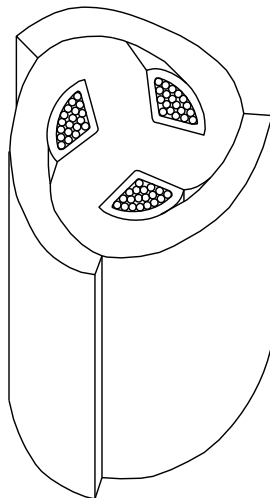
Scotchfil 'Y' Piece

Fig 1



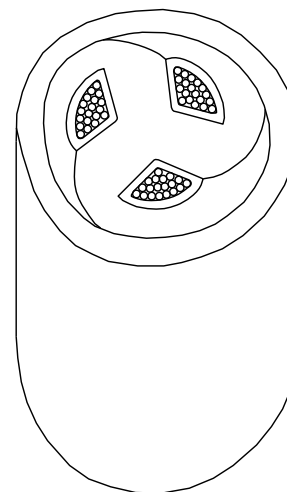
'Y' Piece Applied To Cores

Fig 2



'Y' Piece Moulded To Cores

Fig 3



Completed Core Seal

Fig 4

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				CRUTCH SEAL FOR PVC CONCENTRIC SERVICE CABLES - THREE PHASE	
				Drg. No. GRD 6.38.2	
				Rev No	

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## **GENERAL REQUIREMENT 39**

### **CAPPING OF CABLE ENDS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

The capping of cable ends is very important especially with paper insulated cables, to prevent the ingress of moisture. With more modern insulating materials such as PVC, XLPE etc. the need to prevent moisture is to allow the resin to seal effectively, prevent the corrosion of aluminium conductors as well as the requirement for electrical safety when working on these cables.

There are three methods of capping cables: -

Cold shrink or Heat Shrink Cap

Denso Tape – temporary sealing only i.e. 24 hrs.

Plumbed Seal – not detailed in this section

#### **39.1 COLD SHRINK CAP**

The most commonly used, can be applied to all cable types. Before preparing and applying, a cap of the correct size must be selected, caps are range taking to suit variable cable diameters and to ensure a good moisture seal the selection is most important.

##### **Methods of Application**

##### **PVC Oversheathed Cables – Drawing GRD 6.39.1**

1. Select correct cap to suit cable diameter, ensure the cap is coated internally with sealant and not pin-holed.
2. Clean and degrease PVC oversheath – Fig 1.
3. Slide the cap onto the cable pushing well onto the cable end.
4. Pull the spiral out of the cold shrink cap in an anti-clockwise direction until the cold shrink cap is fully shrunk onto the cable.

#### **39.2 HEAT SHRINK CAP**

The most commonly used, can be applied to all cable types. Before preparing and applying, a cap of the correct size must be selected, caps are range taking to suit variable cable diameters and to ensure a good moisture seal the selection is most important.

## **Methods of Application**

### **PVC Oversheathed Cables – Drawing GRD 6.39.1**

1. Select correct cap to suit cable diameter, ensure the cap is coated internally with sealant and not pin-holed.
2. Clean and degrease PVC oversheath – Fig 1.
3. Abrade the PVC oversheath to the length of the cap abrading is to be undertaken circumferentially ensuring all glossing of the sheath is removed. General Requirement 32.
4. Clean the abraded area thoroughly with an approved degreaser – Fig 1.
5. Slide the cap onto the cable pushing well onto the cable end – Fig 2.
6. Using a soft blue flame start shrinking from the closed end of the cap and work towards the open end. Ensure the flame is worked evenly round the cap, ensuring enough heat is given to melt the sealant coating – Fig 3.
7. Once the cap has fully shrunk into position a ring of sealant will be seen around the cable sheath at the cap end – Fig 4.

### **PILCSTA/PILCSWA Cables – Drawing GRD 6.39.2**

The cable must be prepared down to the lead sheath, the cap must not be placed over the outer serving etc.

1. Select correct cap to suit cable diameter, ensure the cap is coated internally with sealant and not pin-holed.
2. Mark outer serving the length of the cap plus 50mm from the cable end, apply a wire binder to the cable at this point – Fig 1.
3. Remove outer serving, armour and bedding – General Requirement 10.
4. Thoroughly clean the lead sheath from all traces of bitumen.
5. Ensure any sharp edges at the end of the lead sheath are removed with a file.
6. Clean the lead sheath with an approved degreaser and abrade the lead sheath circumferentially up to the termination of the outer serving etc, using a file card – Fig 1.
7. Clean the abraded area with an approved degreaser.
8. Slide the cap onto the cable pushing well onto the cable end.

9. Using a soft blue flame starting shrinking from the closed end of the cap and work towards the open end. Ensure the flame is worked evenly around the cap, ensuring enough heat is given to melt the sealant coating – Fig 2.
10. Once the cap has fully shrunk into position a ring of sealant will be seen around the cable sheath at the cap end – Fig 3.
11. Apply two half lap layers of “88” black PVC tape covering the end of the serving and armour termination, lead sheath and finishing on the heatshrink cap – Fig 4.

### **39.3 DENSO TAPE**

Denso tape is to be used for temporary sealing i.e. 24 hours, it can be applied to all cable types as follows:-

**PVC Oversheathed Cables** – applied direct without any special preparation.

**PILCSTA/PILCSWA Cables** – cables are to be prepared as for heatshrink cap method and the Denso tape must be applied direct to the cleaned lead sheath.

#### **Method of Application**

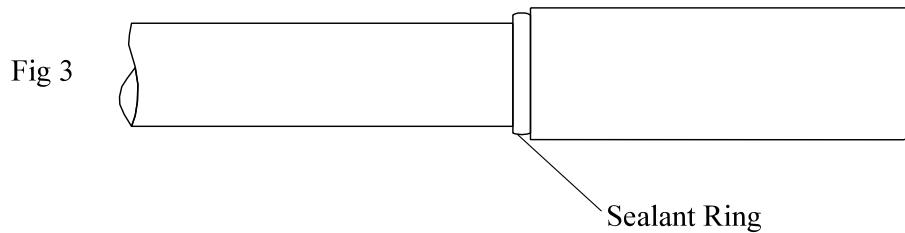
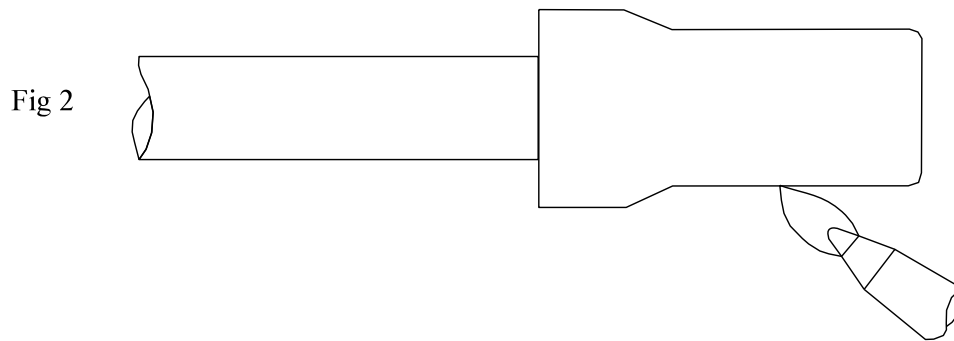
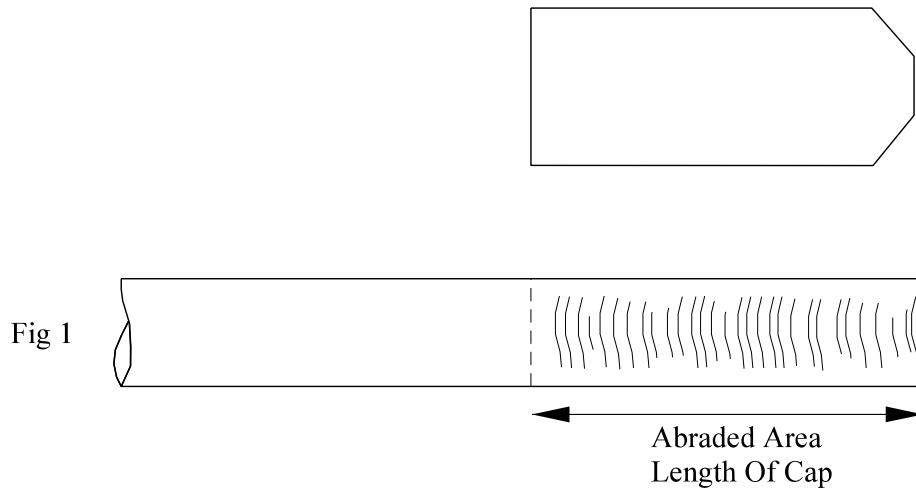
Disposable gloves are to be worn when applying.


The tape is to be applied with a minimum of two half lapped layers, as each layer is applied the paste within the tape must be worked well through the tape.

Starting on the cable sheath a minimum of a width and one half of the tape from the cable end, wrap towards the cable end, with a criss-cross action apply the required layers across the cable end returning to the start point.

Cut the tape and ensure the paste is worked well into the taped end.

All dimensions in mm



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				CAPPING OF CABLE ENDS PVC CABLES	
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				Rev No	

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All dimensions in mm

Fig 1

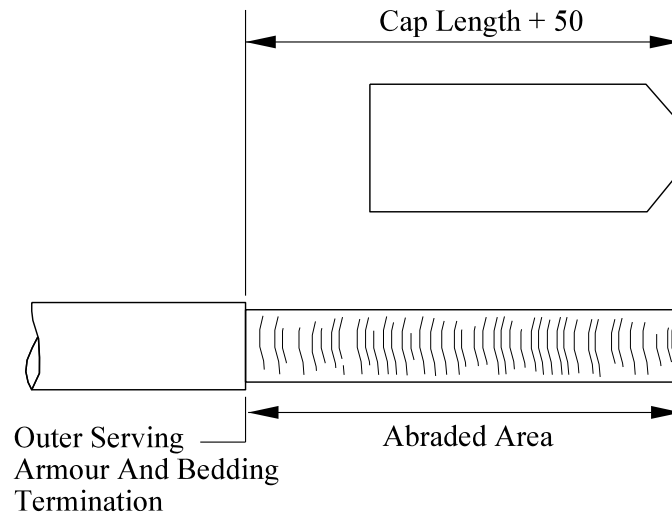


Fig 2

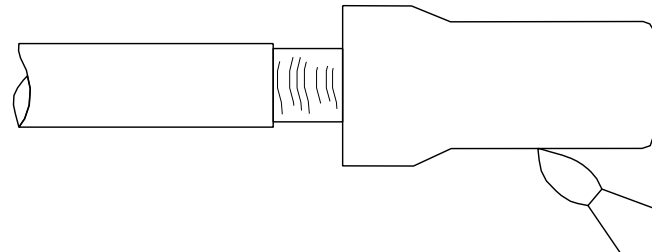


Fig 3

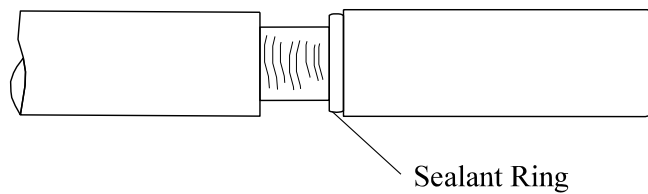
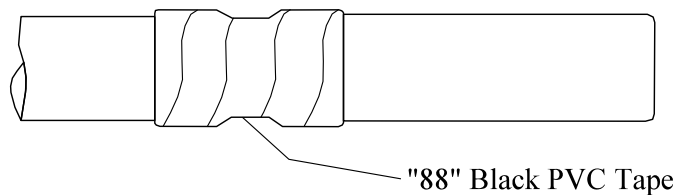


Fig 4



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## **GENERAL REQUIREMENT 40**

### **REPAIRS TO DAMAGED PVC CABLE OVERSHEATHS**

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, also your attention is drawn to the Use of Solvents General Requirement 1.

This General Requirement contains the approved method for the repair of damaged PVC oversheaths of Wavecon mains and PVC concentric service cables.

Before the repair is attempted it is important to ensure the damage is limited to the PVC oversheath only, and if any doubt exists that there is damage to the underlying copper wires then this type of repair shall not be undertaken.

#### **40.1 MAINS CABLES – Drawing GRD 6.40.1**

Material:-

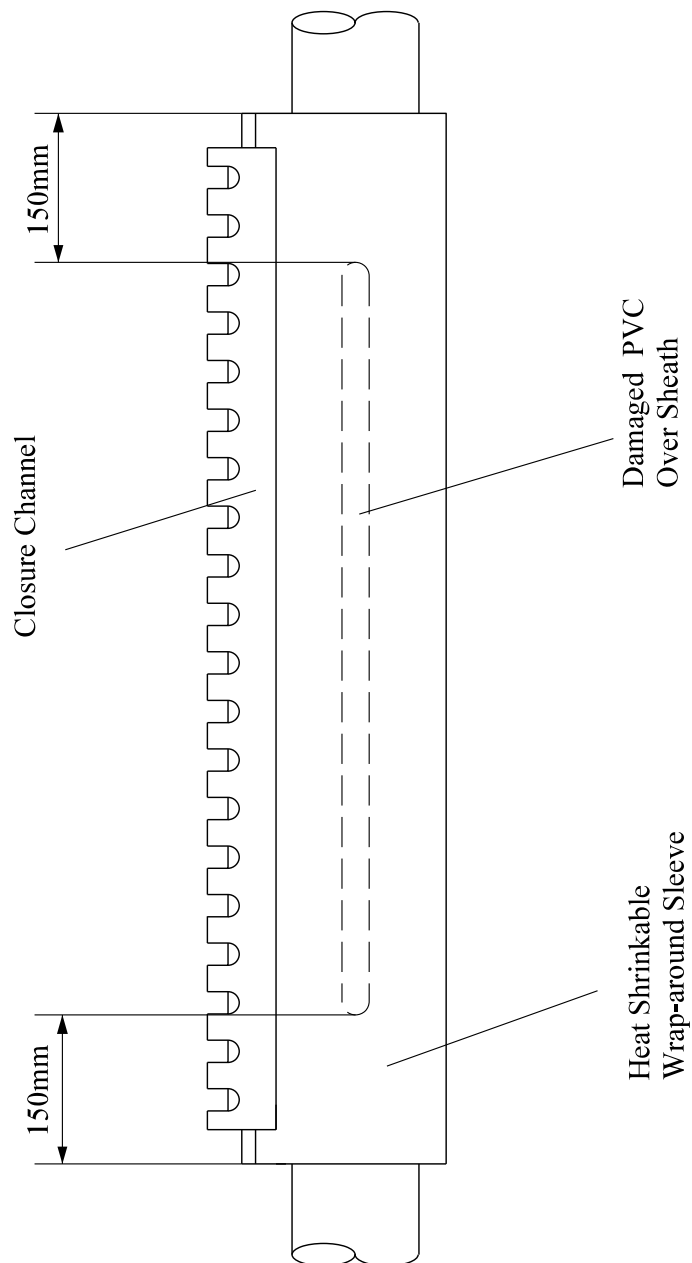
Heatshrink Wraparound Sleeving


- CRSM 53/13 -1500 covers cables diameters within this range
- CRSM 88/20 -1500 covers cables diameters within this range

#### **Installation**

1. Select the sleeve to match the cable diameter.
2. Confirm the damage is limited to the PVC oversheath.
3. Clean the PVC oversheath with an approved degreaser, the length of the damage plus 150mm either side and abrade cleaned length either side of the damage.
4. Cut the sleeving to length, length of the damage plus 300mm.
5. Wrap the sleeving round the cable and fit the closure channel.
6. Centralize the sleeving ensuring the abrasions are covered.
7. Shrink the sleeve into place starting at the centre and working towards the ends.

All dimensions in mm



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Checked			Title <b>REPAIR TO DAMAGED PVC CABLE OVERSHEATHS</b>			Drg. No. <b>GRD 6.40.1</b>
Approved						
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## **GENERAL REQUIREMENT 41**

### **THE SET UP AND CONVERSION OF 2 OR 4 WAY PRYSMIAN LINK DISCONNECTION BOX**

Before commencing the level of PPE required for this operation shall be as the matrix given in the General Requirement 3, also your attention to the Use of Solvents General Requirement 1.

It is important that the set up of 2 and 4 way link disconnection boxes are level and the excavation depth is such that on completion there is sufficient adjustment that the pavement cover is level with the pavement surface.

Where the box is required to be placed on a SNE (4 core Wavecon) system a conversion will be required to change the configuration of the neutral/earth bus bar to two separate bus bars within the box i.e. neutral and earth.

Also where the connection of generators or testing is required to the link box an external earth stalk can be fitted to the LDB.

#### **41.1 EXCAVATION AND BOX SET UP – Drawing GRD 6.41.1**

1. Excavate the bay to the dimensions given as a guideline in the drawing.
2. Lay a 600 x 600mm concrete slab, for a two way LDB or a 900 x 600mm concrete slab, for a four way LDB base on a level bed of stone dust or sand to provide a depth of  $540 \pm 10$ mm measured from the top of the slab to top of the prepared footpath surface.

#### **41.2 PAVEMENT ACCESS ARRANGEMENT – Drawing GRD 6.41.2**

1. Position the base LDB chamber centrally on the concrete slab and add the remaining two sections of the chamber to the base unit.
2. Ensure the set screws assemblies are located into the pre-drilled holes.
3. Position the galvanised steel frame on top of the chamber and locate the set screw assemblies.
4. Set the height/level of the concrete cover(s) using the screw adjustment.
5. Ensure all set screw assemblies are in contact with the underside of the locating rim before locking the assemblies in position.



### **41.3 CONVERSION FROM CNE TO SNE – Drawing GRD 6.41.3, GRD 6.41.4**

#### **2 Way LDB Conversion Kit Ref. U8208005**

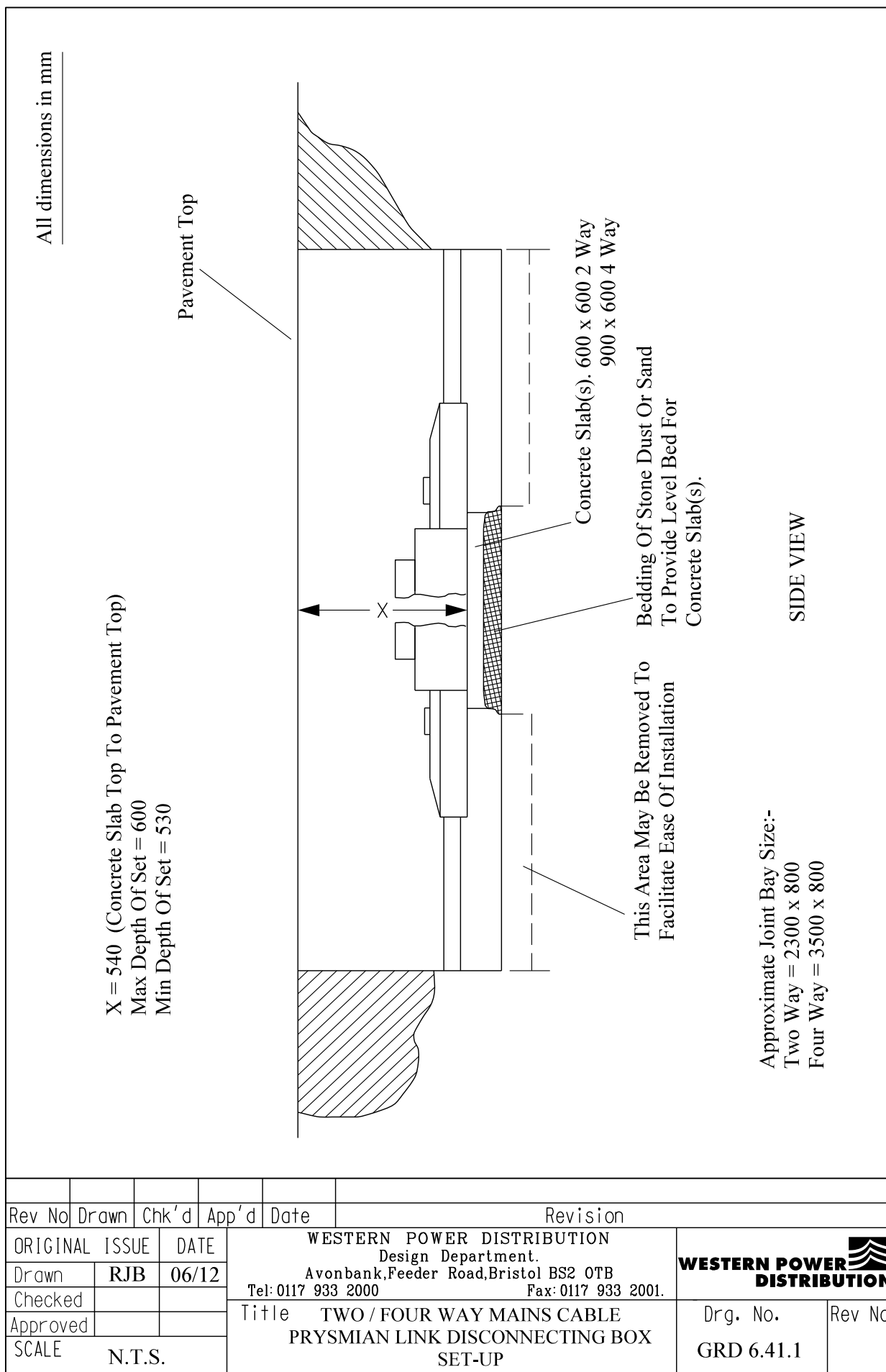
1. Position the earth bus bar complete with earth connectors to the underside of link box base chamber.
2. Slide the two foam spacers down the earth bar and park them against the base chamber sidewall.

#### **4 Way LDB Conversion Kit Ref. U8208004**

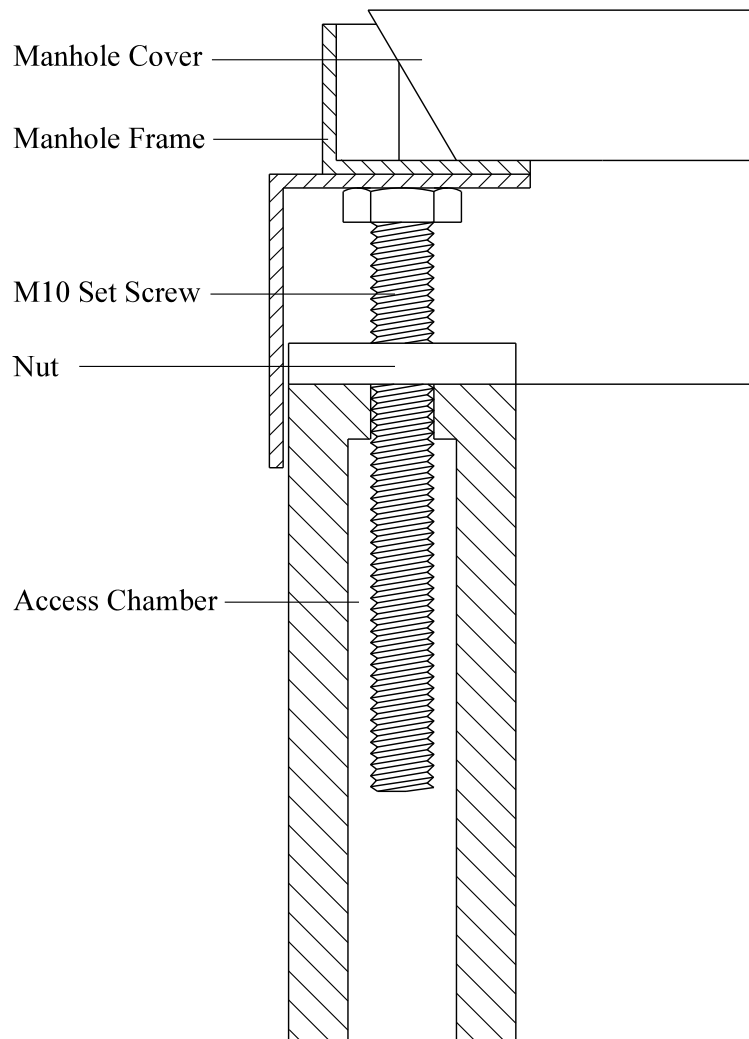
1. Position the earth bus bar complete with earth connectors to the underside of link box base chamber.
2. Slide the two foam spacers down the earth bar and park them against the base chamber sidewall.


### **41.4 LIVE WORKING WITH PRYSMIAN LDB - Drawing GRD 6.41.5**

1. If the LDB is to have the conversion kit fitted, fit the SNE conversion kit to the LDB base section of the chamber, as per clause GR 41.3 above; otherwise locate the base chamber centrally, on the concrete plinth.
2. Once the LDB has been positioned centrally on the concrete plinth place a 1000 gauge pole top bag so that the open end of the bag is installed under the base of the LDB chamber so that the bag sits directly under each of the cable pockets. This will provide additional insulation while working between the live cores of the particular cable and the concrete plinth. See drawing GRD 6.41.6.
3. If the SNE conversion is required, make off the earth connection first and shroud all exposed metalwork with 1000 gauge polythene as per GR 21. Otherwise make off the neutral /earth connection a shroud with the rubber patch as per GR 30, then shroud all other exposed metalwork with 1000 gauge polythene as per GR 21.
4. If the SNE conversion is required, then make off the neutral connection and shroud with the rubber patch as per GR 29/30, then shroud all other exposed metalwork with 1000 gauge polythene as per GR 21.
5. Using UST connectors, one at a time make off the phase conductors and insulate as per GR 29/30.



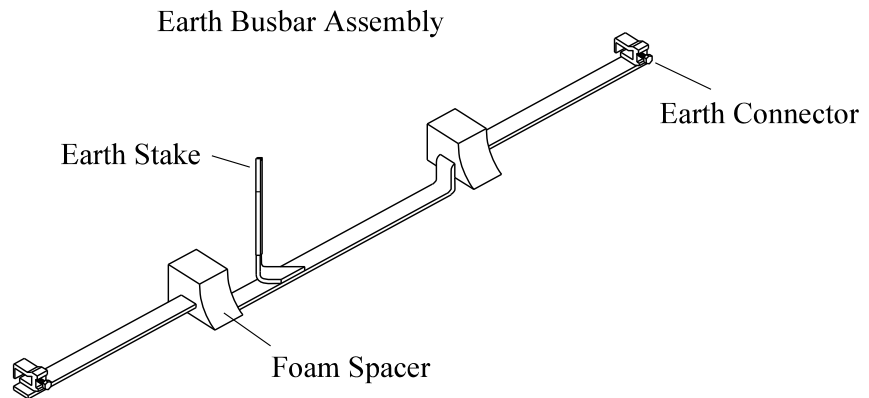
All dimensions in mm



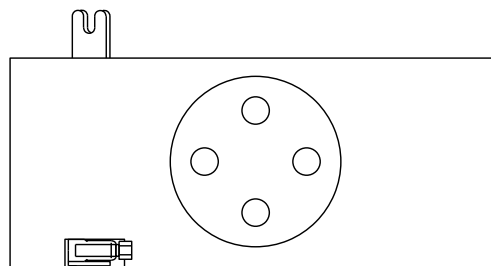
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SCALE	N.T.S.		Title <b>TWO / FOUR WAY MAIN CABLE LINK DISCONNECTING BOX- ACCESS CHAMBER SET UP</b>			Drg. No. GRD 6.41.2
						Rev No

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Conversion Kit Ref: U8208004



Turret Conversion

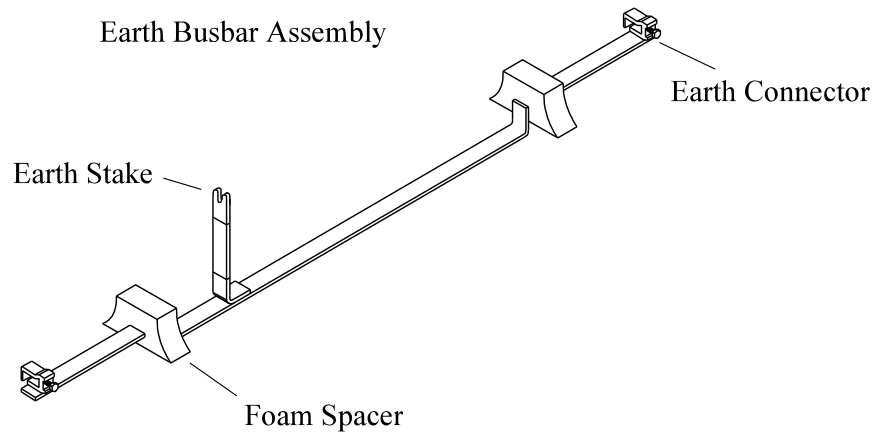


END VIEW

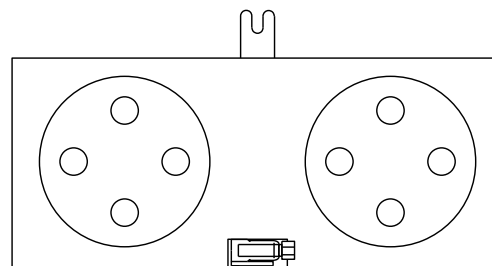
Rev No	Drawn	Chk'd	App'd	Date	Revision	
ORIGINAL	ISSUE	DATE	<b>WESTERN POWER DISTRIBUTION</b> Design Department. Avonbank, Feeder Road, Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.			 <b>WESTERN POWER DISTRIBUTION</b>
Drawn	RJB	06/12				
Checked						
Approved						
SCALE N.T.S.			Title <b>TWO WAY MAINS CABLE</b> <b>PRYSMIAN LINK DISCONNECTING BOX -</b> <b>SNE CONVERSION GENERAL LAYOUT</b>			Drg. No. <b>GRD 6.41.3</b> Rev No

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Conversion Kit Ref: U8208005



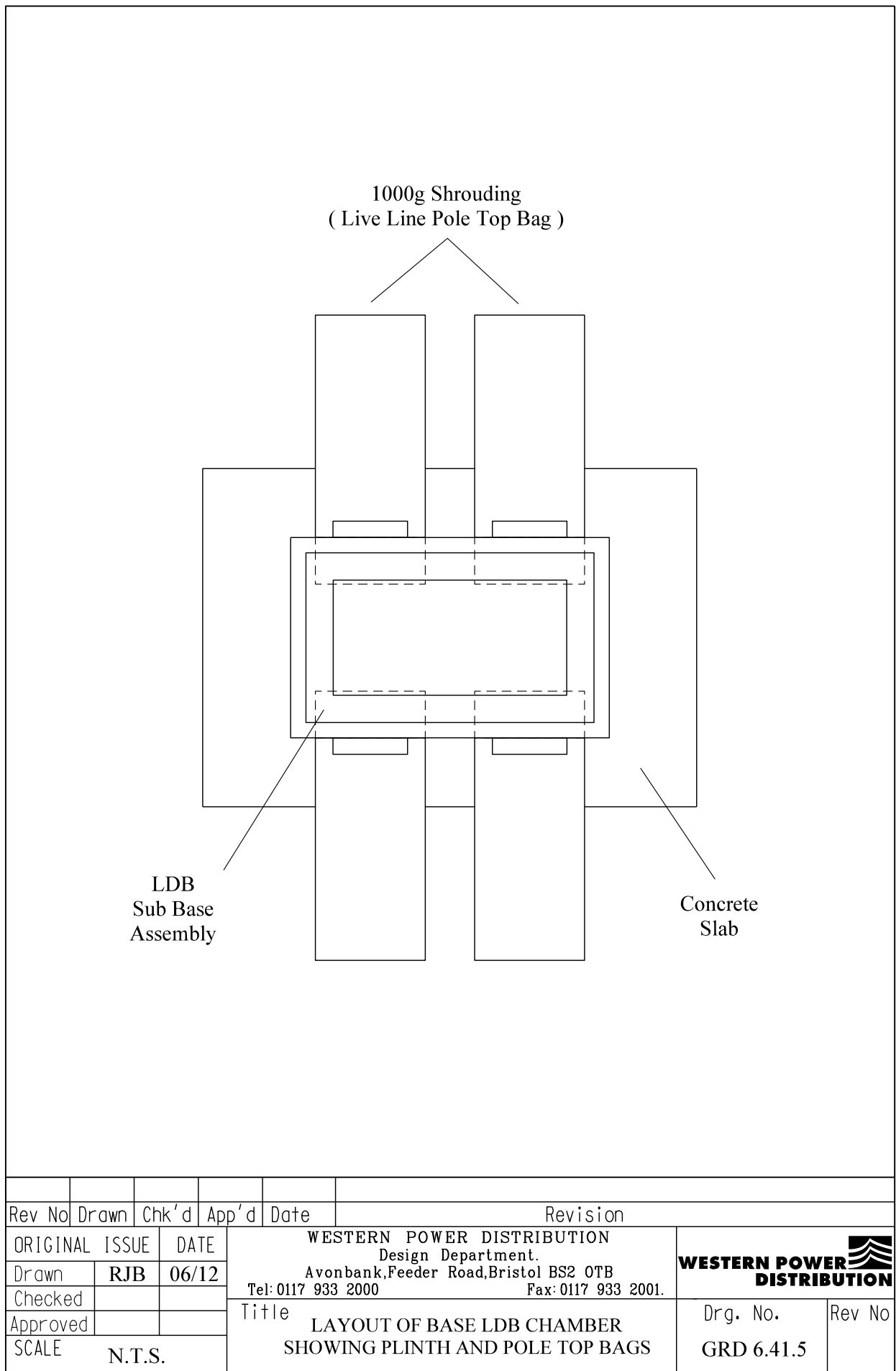
Turret Conversion



END VIEW

Rev No	Drawn	Chk'd	App'd	Date	Revision	
ORIGINAL	ISSUE	DATE	<b>WESTERN POWER DISTRIBUTION</b> Design Department. Avonbank, Feeder Road, Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.			 <b>WESTERN POWER DISTRIBUTION</b>
Drawn	RJB	06/12				
Checked						
Approved						
SCALE	N.T.S.		Title <b>FOUR WAY MAINS CABLE</b> <b>PRYSMIAN LINK DISCONNECTING BOX -</b> <b>SNE CONVERSION GENERAL LAYOUT</b>			Drg. No. <b>GRD 6.41.4</b> Rev No

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## GENERAL REQUIREMENT NO. 42

### IZUMI SB-3UK SHEARBOLT TOOL.

This tool is designed for use by WPD Jointing staff that is undertaking jointing activities, which use mechanical connectors containing shearbolts. The following jointing activities are included: -

Live and dead LV Mains jointing, dead 11kV jointing and dead 33kV jointing.

**Note:** - The Izumi Shearbolt tool is not to be used on the B&H MSIP connector.

#### 42.1 Components

The tool comes with the following items: -

Izumi SB-3UK shearbolt tool.

Nickel Cadmium (Ni-Cd) 14.4V battery.

Izumi CH-70DC charger.

Rubber battery shroud.

Plastic toolbox.

#### 42.2 Batteries

It will take approximately 6 to 8 charging and discharging cycles to build up to the maximum power in new batteries. A battery should give anything between 400 and 600 cycles, typically 12 to 18 months if cycled on a daily basis. The sign of a battery coming to the end of its life would be the battery going flat after very little use, because it does not hold its charge.

Ni Cad cells are prone to building up a memory if not fully discharged on a regular basis. In effect, this means that if your battery is only 50% flat and you charge it repeatedly, the battery registers the 50% charge state as being its flat state and will thus only give you 50% of its capacity. **All batteries must be completely discharged by normal use before re-charge to get the most out of them.**

Charger Model	Charging Time	Remarks
<b>CH-25EMC 220/240V</b>		Refresh function: - By pressing discharge switch to avoid battery memory effect, the Charger will discharge battery and recharge automatically. For fully charged batteries, time required: - BP-70E & EI = 10 Hrs.
	BP-70R 1.2Ah - 15 Minutes	
	BP-70I 1.2Ah with LED - 15 Minutes	
	<b># BP- 70E 2Ah - 20 Minutes</b>	
	BP-70EI 2Ah with LED - 20 Minutes	
	BP-250RI 4Ah - 45 Minutes	
<b>* CH-70DC 12 V</b>	Inverters are now available to enable use in vehicle.	Power source: - 12 / 24V DC car / vehicle battery Connected to cigarette lighter.
	BP-70R 1.2Ah - 60 Minutes	
	BP-70I 1.2Ah with LED - 60 Minutes	
	<b>* BP- 70E 2Ah - 90 Minutes</b>	
	BP-70EI 2Ah with LED - 90 Minutes	
	BP-250RI 4Ah - 180 Minutes	

**\* Standard issue with W.P.D. tools.**

## **42.3 Operation**

### **Battery Charging: -**

1. Connect the battery charger plug to the supply.
2. Insert battery pack into the charger.
3. Charging takes approx. 20 to 90mins depending on the charger used.

### **Battery Insertion**

1. To insert the battery into the tool body, insure battery is facing in the correct direction, and then push the charged battery firmly into place until a click is heard.
2. After inserting a battery, check that it is securely in place by gently pulling on the battery. Do not press the locking latch while pulling the battery.

### **Speed Control**

1. The trigger has a built-in variable speed control. As the trigger is pressed the speed increases gradually to a maximum when fully depressed.
2. The drive rotates when the trigger is pressed and stops when the trigger is released.
3. To reverse the drive, move the reverse switch (on side of tool) to position “R” and press the trigger as before.

### **Shearing the Bolts**

1. Place the mechanical connector onto the conductor in accordance with the manufacturers recommendations and “finger tighten” all bolts.
2. Fit the right size socket for the shear bolts on the mechanical connector to the ½” drive shaft of the tool.
3. Check that the forward/reverse switch on the side of the tool is in the forward position “F”.
4. Place the socket over the first shear bolt and press the trigger until the shearbolt shears, release the trigger.
5. Repeat on all bolts in the sequence of the manufacturers recommendations until all shearbolts have sheared.



#### 42.4 Precautions

Never use the tool to place the shearbolts in the mechanical connector, **always** use fingers and make sure the shearbolt is not cross threaded. Prior to shearing make sure that the tool is in forward rotation before placing the socket over the shearbolt.

Do not drop the tool. Dropping the tool may damage the internal gears and result in the tool not functioning correctly.

Always store in the case provided when not in use.

Before commencing the level of PPE required for this operation shall be as the matrix given in General Requirement 3, your attention is drawn to the use of **Ear Defenders**.

## **APPENDIX A**

### **SUPERSEDED DOCUMENTATION**

This Standard Technique supersedes ST:CA1C/7 dated May 2017 which should now be withdrawn.

## **APPENDIX B**

### **ASSOCIATED DOCUMENTATION**

ST: CA1A, ST: CA1B, ST: CA1C/5, ST: CA1 D, ST: CA1E, ST: CA1F, ST: CA1G, ST: CA1H, ST: CA1I, ST: CA1U, ST: CA1W, ST: CA1X, ST: CA1Y, ST: CA1Z, ST: CA1AA, ST: CA1AB, ST: CA7A, ST: CA7B, ST: CA7C, ST: CA7D.

## **APPENDIX C**

### **KEY WORDS**

All General Requirements for LV Mains Jointing.