# 4 INSTALLING HEATSHRINK MATERIALS AND COMPONENTS

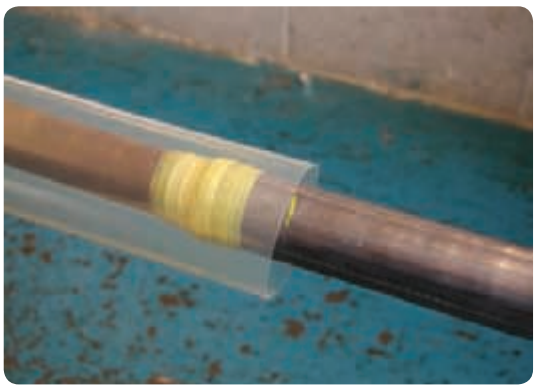
## 4.1 Installing Stress Control and Insulation Materials

### 4.1.1 Single-Core Paper Insulated Cables in Transition Joints

- Prepare the cable as described in section 3.2. Use a chinagraph pencil to mark 20mm onto the lead sheath and 10mm onto the insulation papers.

- Remove the release paper from the medium length of yellow stress control tape. Stretch the tape to about half its original width and wrap it around the lead sheath for 20mm. Remove the twine binder from the screen edge and continue with the tape over the screen papers and onto the insulation for 10mm.

- Use a chinagraph pencil to mark the lead sheath 20mm beyond the yellow stress control tape. Position the clear barrier tubing over the core end and over the yellow stress control tape, overlapping onto the lead sheath by 20mm.



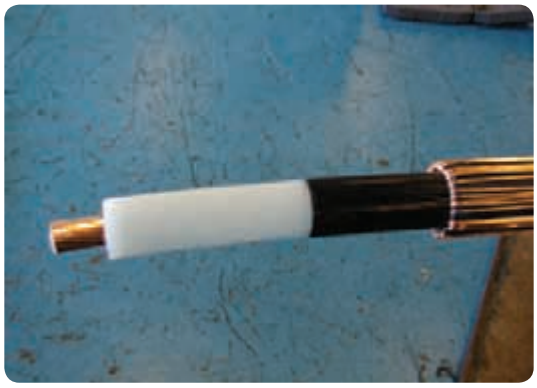
- Shrink the tubing down, starting on the lead sheath and continuing towards the core end. Once completed the tubing should be fully shrunk and have a smooth finish without wrinkles or creases.

- Position the short black conductive sleeve 220mm from the core end and shrink the tubing down starting at the open cable end before working towards the lead sheath.

### 4.1.2 Single-Core Polymeric Pot Ends

- Prepare the cables as described in section 3.1 up to and including the screen removal point. The dimension for the screen is 80mm.

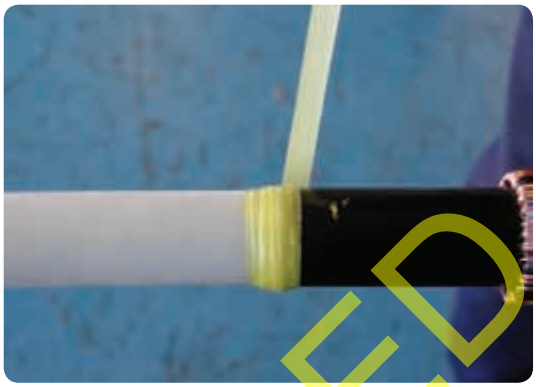
- Remove the insulation for 30mm from the end of the cable.



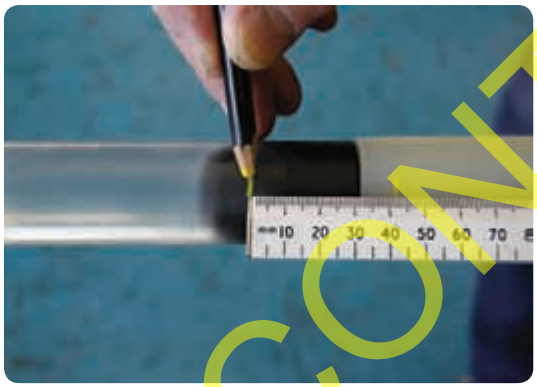
- Clean and degrease the insulation with an approved solvent wipe to remove all traces of conducting material. Always wipe from the open cut end towards the screen wires to avoid contaminating the insulation with carbon from the screen layer.
- Wrap the conductive tape supplied in the jointing kit around the 30mm of exposed conductor stretching it to about half its original width.

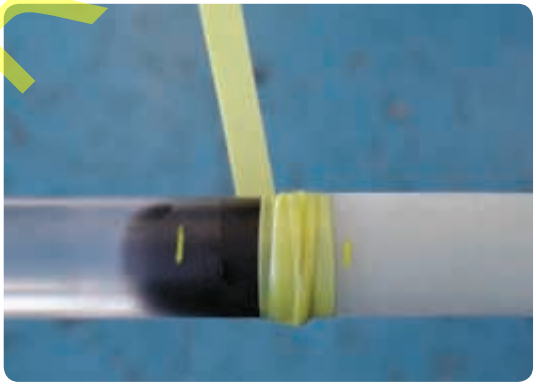
- Increase the conductor diameter sufficiently so that the insulating rod is a snug fit over the conductor. Push the insulating rod onto the conductor ensuring that it butts against the cable insulation.

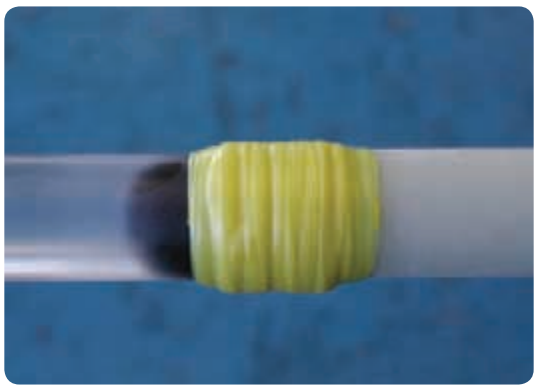
- Use a short strip of yellow stress control mastic and remove the release papers from a short strip of yellow stress control mastic tape. Wrap it around the edge of the insulation screen starting 20mm from the screen edge, before continuing for 10mm on to the core insulation. Stretch the tape to approximately half its original width to obtain a fine edge onto the insulation.

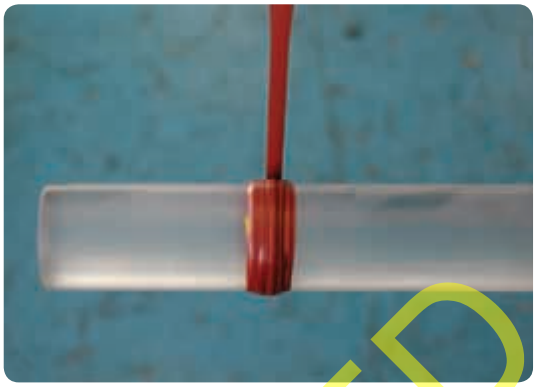
- Using a long strip of yellow stress control mastic and remove the release papers. Wrap it around the core insulation starting 10mm from the insulation edge, before continuing on to the insulating rod covering the 'painted area' and 10mm beyond on to the rod insulation.
- Use only as much of the yellow stress control mastis as necessary to fill in the step between the insulation and the rod.



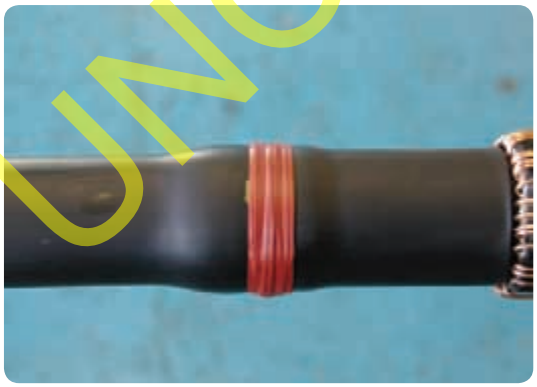


- Wrap one layer of red mastic around the insulating rod 60mm from its end and with a width of 10mm.

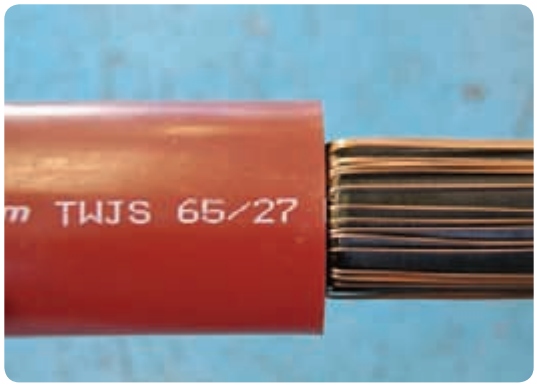


- Position the black stress control tubing over the insulating rod and butt it up against the cable oversheath cut. Shrink the tubing down starting at the oversheath end before working towards the insulating rod end.

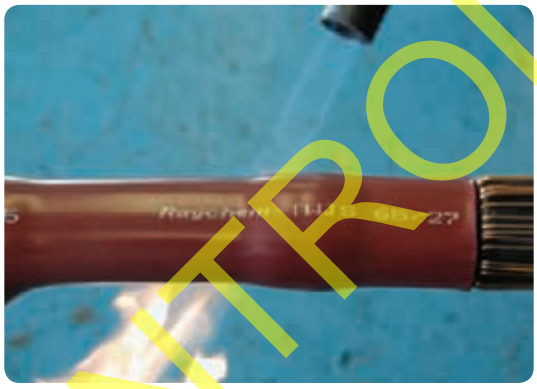
- Use one layer of red mastic around each end of the installed stress controlled tube 60mm in from each end and with a widteh of 10mm.



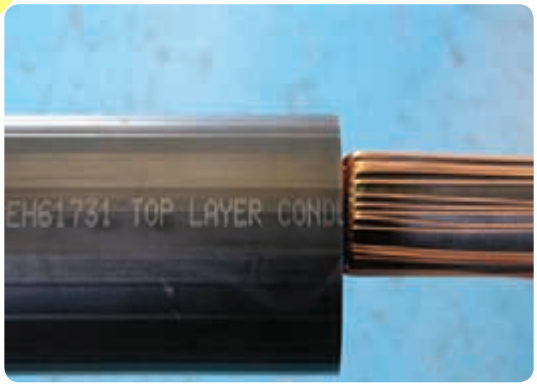
- Slide the red insulating tubing over the stress control tube butting it against the cable over-sheath and coinciding with the stress control tubing edge.




- Shrink the tubing down starting at the over-sheath end and working towards the insulating rod end.



- Place the black and red screened insulating tubing over the assembly and position it to coincide with the previously installed tubes.

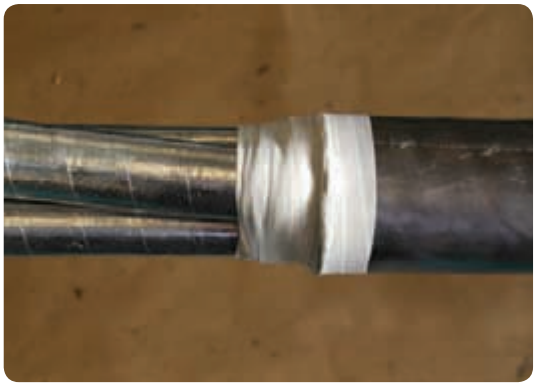


- Shrink the black and red tube down starting in the centre. When this section is fully shrunk it should be smooth without ridges and should not move when twisting the tube end.

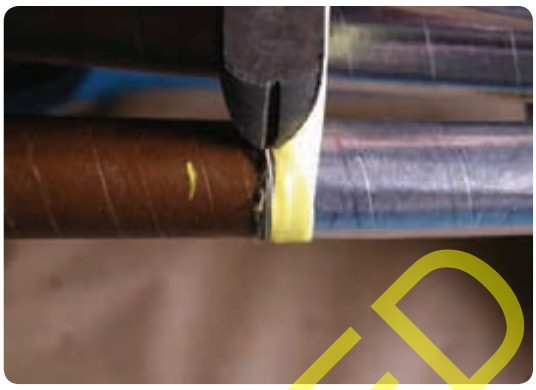
- Continue the shrinking process, working towards one end and stopping 50mm from the end. Then shrink towards the opposite end stopping 50mm from the end. Finally shrink down the first remaining 50mm of tubing followed by the second 50mm of tubing. This process ensures that no air is trapped inside the tube.

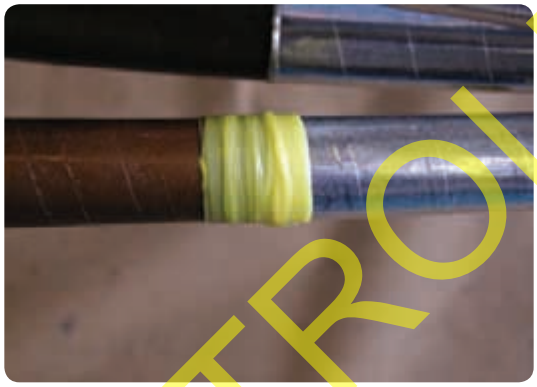
### 4.1.3 Resin Filled Three-Core Transition Straight Joints (Three-Core Paper to 3 x Single-Core Polymeric Cables)

- Prepare the cables up to the point as described in section 3.3.
- Protect the Copper Woven Tape (CWT) with nylon tape, starting from 20mm onto the lead sheath extending 30mm onto the cores. The nylon tape should be applied with tension.

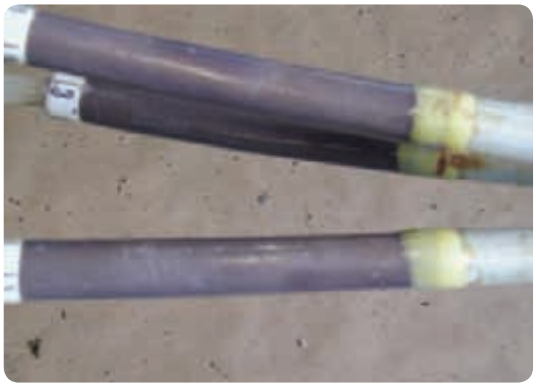


- At the screen termination position wrap one layer of void filling yellow stress control mastic around each core, overlapping the screen papers by 20mm and the insulation by 10mm. Remove the metal binder from the screen edge during the taping process.

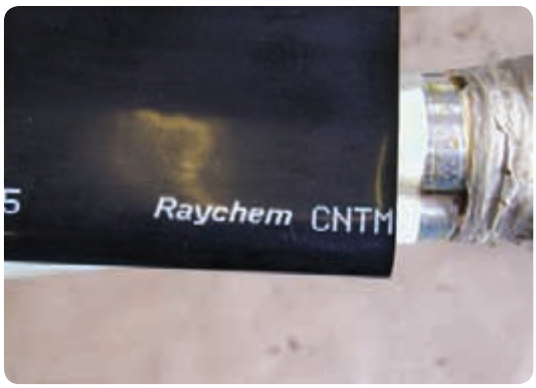




- Slide the clear barrier tubing over each core and position 30mm from the end of the metal sheath. Shrink down the tubing starting at the crutch position working towards the open core ends. Check the tubing is shrunk down evenly and free from creases or wrinkles.



- Slide the black conducting tubing over the core ends and position them 50mm from the end of the metal sheath. Shrink the tubes down at this position starting at the crutch before working towards the core ends.





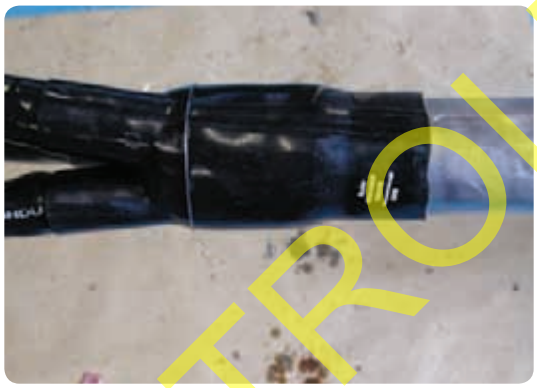
- Slide the small yellow mastic wedge into the crutch using the installation tool provided. Take the larger wedge and insert it into the crutch behind the smaller wedge using the same tool. Remove the nylon tape after insertion of both wedges.



- Degrease the cores using approved solvent wipes. Make a chinagraph pencil mark on the conductive tubes 70mm from the lead sheath cut and for 20mm onto the lead sheath.

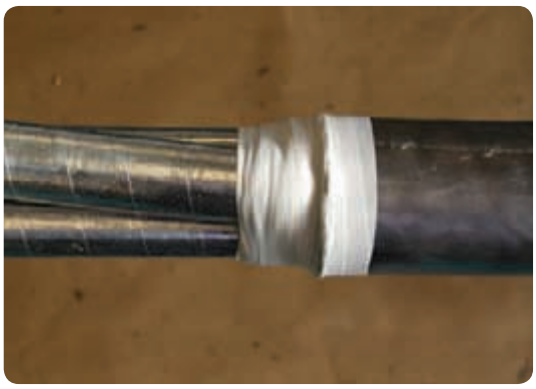
- Wrap strips of yellow mastic around the crutch between the two chinagraph pencil marks. Apply sufficient tension to stretch the tape to half its original width until a 'cone' shape is formed.

- Pass the conductive breakout over the cores and push it well down into the crutch, using the yellow wedge installation tool. Hold the breakout in place and shrink it down starting at the centre, before firstly working towards the lead sheath and then towards the breakout fingers.

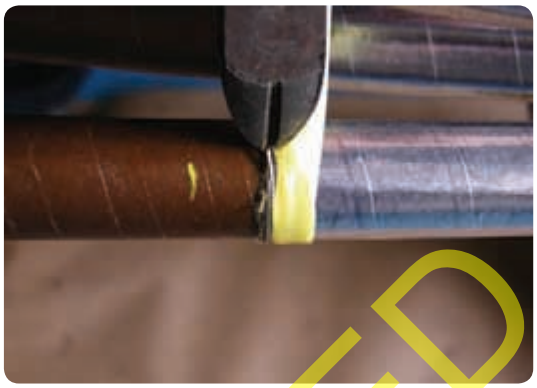


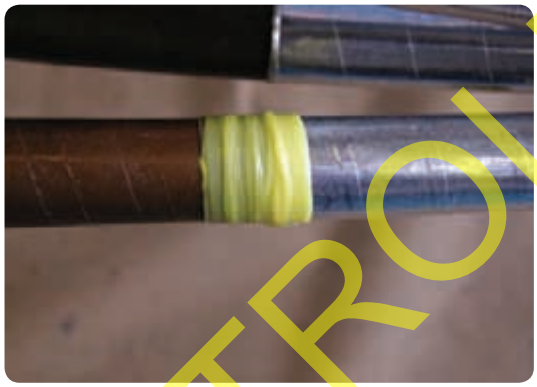
### 4.1.4 Heatshrink Three-Core Transition Straight Joint (Three-Core Paper to 3 x Single-Core Polymeric Cables)

- Prepare the cables up to the point as described in section 3.3.
- Protect the CWT with nylon tape, starting 20mm onto the lead sheath extending 30mm onto the cores. The nylon tape should be applied with tension.



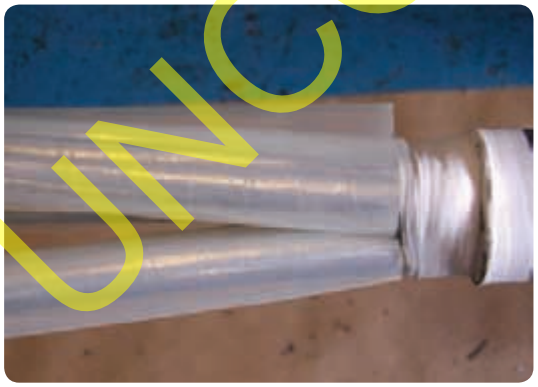
- At the screen termination position wrap one layer of void filling yellow stress control mastic around each core overlapping the screen papers by 20mm and the insulation by 10mm. Remove the metal binder from the screen edge during the taping process.

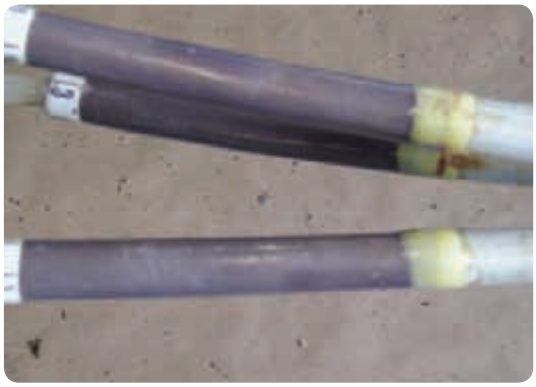




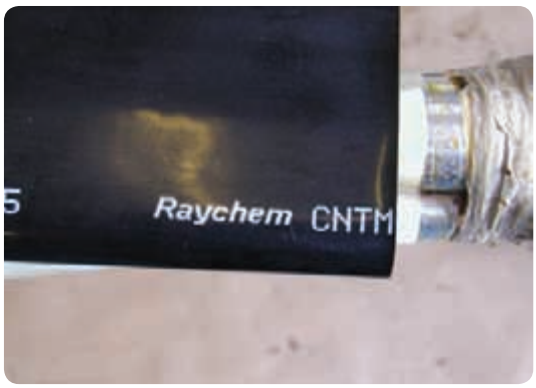


- Slide the clear barrier tubing over each core and position 30mm from the end of the metal sheath. Shrink down the tubing starting at the crutch position before working towards the open core ends. Check the tubing is shrunk down evenly and is free from creases or wrinkles.





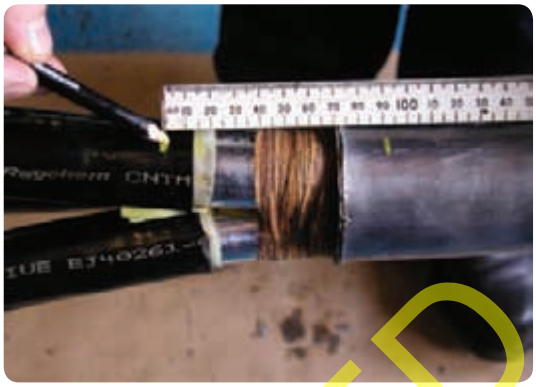
- Slide the black conducting tubing over the core ends and position them 50mm from the end of the metal sheath. Shrink the tubes down at this position starting at the crutch working towards the core ends.





- Slide the smaller supplied yellow mastic wedge into the crutch using the installation tool provided. Take the larger wedge and insert it into the crutch behind the smaller wedge using the same tool. Remove the nylon tape after insertion of both wedges.

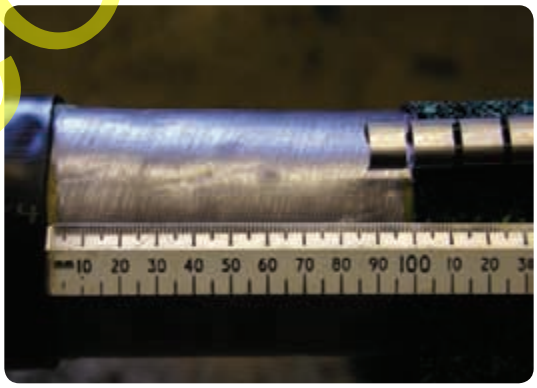
- Degrease the cores using approved solvent wipes. Make a chinagraph pencil mark on the conductive tubes 70mm from the lead sheath cut and for 20mm onto the lead sheath.



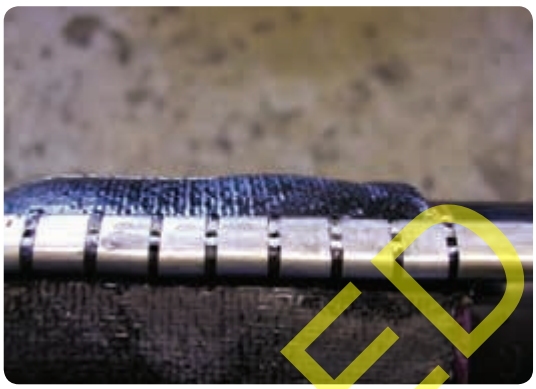
- Wrap the strips of yellow stress control mastic around the crutch between the two chinagraph pencil marks. Apply sufficient tension to stretch the tape to half its original width until a cone shape is formed.

- Pass the conductive breakout over the cores and push it well down into the crutch, using the yellow wedge installation tool. Hold the breakout in place and shrink it down, starting at the centre before working towards the lead sheath and then towards the breakout fingers.

- Position the short length of wrap-around heatshrink tube over the paper cable so that it covers the lead sheath and the three finger break out. Leave a gap of at least 100mm between the end of the wrap around and the armour sealing sleeve.



- Shrink the wrap-around in place starting in the middle, until the surface paint on the tube turns from green to black. Then gradually move to each end using the same process. Extra heat should be applied to the metal channel until the white marker line can be clearly seen under it.

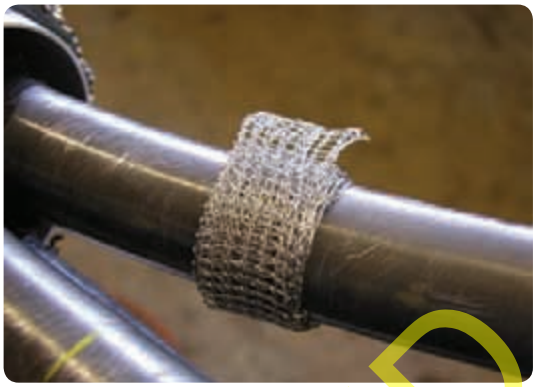


- Position the short sealing heatshrink tubes over the turrets of the heatshrink breakout, ensuring they are pushed right into the crutch and shrink in place.

### 4.1.5 HSL Breakout Module

- Prepare the cables up to the point as described in section 3.4.1 to 3.4.3.
- Use a chinagraph pencil to mark each lead sheath 100mm from the armour cut edge. Fold a short length of tinned copper mesh in half length ways.

- Wrap the tinned copper mesh around the lead sheaths centered on the 100mm mark.

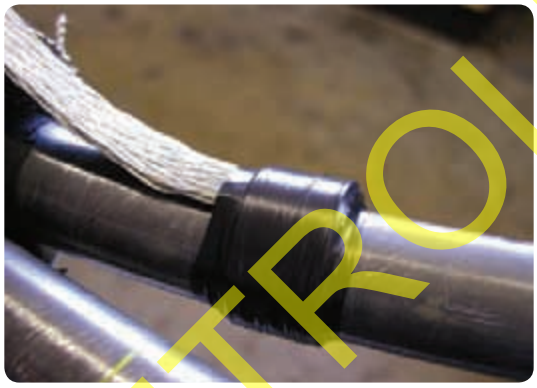


- Position one of the lengths of braid over the mesh so that the loose end points away from the crutch of the cable.

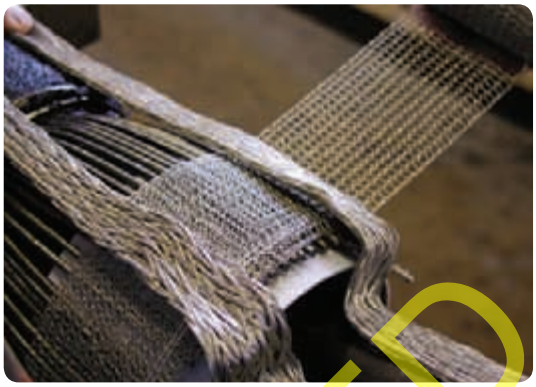
- Secure a length of earth braid to each lead of the lead sheaths using one turn of the roll springs directly on to the copper mesh wrap.

- Bend the braids back over the roll spring and then secure in place with the remaining turns.

- Cover each of the roll springs with two layers of PVC tape.



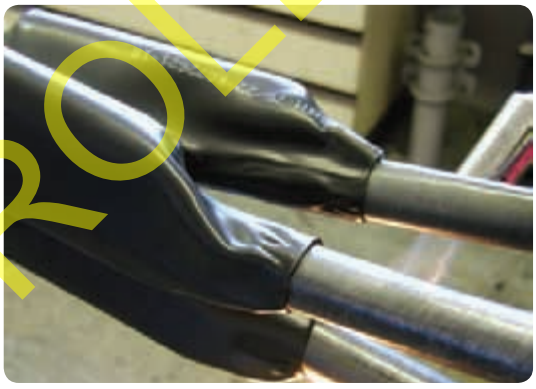
- Secure the braid ends to the armours and the support ring with a roll of tinned copper mesh sandwiching the braids between the mesh wraps.



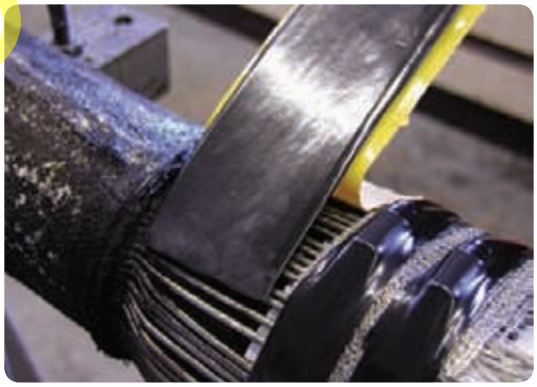
- Finally, secure the mesh and braids to the support ring and armours using the worm drive clips provided, with one clip either side of the support ring's central ridge.

- Cover the worm drive clips with PVC tape to tidy up their loose ends.

- Slide a sealing sleeve over each lead sheath and roll spring connection up to where the earth braid meets the support ring. Shrink them down starting on the lead sheaths and continuing towards the armour wires area.



- Wrap a strip of black mastic behind the support ring over the armour wires, filling the space between the ring and the outer sheath.



- Pass the breakout over the lead sealing sleeves and pull down into the crutch. Shrink the breakout down starting in the centre before moving towards the over-sheath and then shrink the breakout fingers.

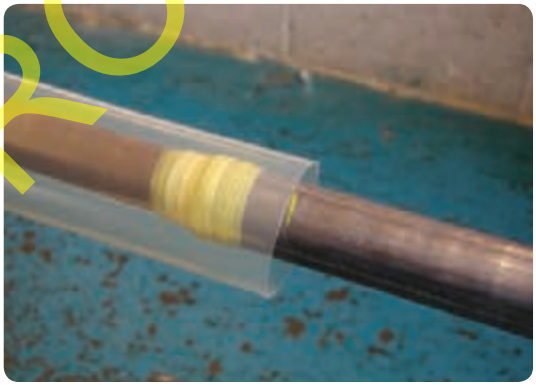
- Position the crutch sealing sleeve with one end level with the end of the fingers on the breakout and shrink into place.

### 4.1.6 HSL Cable Core Preparation

- Prepare the cables as detailed in section 4.1.5 and remove the lead sheaths as described in section 3.4.4.
- Use a chinagraph pencil to mark 20mm onto the lead sheath, and 10mm onto the insulation papers.

- Remove the release paper from one of the medium lengths yellow stress control tape. Stretch the tape to about half its original width and wrap it around the lead sheath for 20mm. Remove the twine binder from the screen edge and continue with the tape over the screen papers and on to the insulation for 10mm.

- Make a mark on the lead sheath using a chinagraph pencil 20mm beyond the yellow stress control tape. Position the clear barrier tubing over the core end and the yellow stress control tape overlapping onto the lead sheath by 20mm.



- Shrink the tubing down, starting on the lead sheath and continuing towards the core end. Once completed the tubing should be fully shrunk and have a smooth finish without wrinkles or creases.

- Position the short black conductive sleeve 220mm from the core end and shrink the tubing down, starting at the open cable end before working towards the lead sheath.

### 4.1.7 Paper Insulation 'Shim Kit' for Cable Cross Sections 70mm² & 95mm²

- For cables below the minimum size range specified on the kit label a 'shim kit' must be used.
- The cables will be at the stage of preparation described in sections 4.1.1, 4.1.3, 4.1.4 or 4.1.6.
- Apply a piece of the yellow stress control tape 20mm over the end of the conductive tube and onto the clear tubing by 10mm. Use some of the yellow tape provided in the main joint kit.

- Position a short length of the smaller diameter stress control tubing (42/16) over the core end, overlapping the conductive tubes and the yellow stress control mastic by 40mm.

- Shrink the stress control tubing down, starting from the yellow mastic tape and working towards the open core end.

- Wrap one of the red mastic strips provided around the end of the stress control tube 30mm on to the tubing and 10mm on to the core.

- Position a short length of the larger diameter stress control tubing (54/24) directly over the previously applied stress control tube and shrink down following the same procedure as before.

- Apply one of the red mastic strips provided around the end of the stress control tube 30mm on to the tubing and 10mm on to the previously applied red mastic.

### 4.1.8 Paper Insulation 'Shim Kit' for Cable Cross Sections 120mm² & 150mm²

- For cables below the minimum size range specified on the kit label, a 'shim kit' must be used.
- The cables will be at the stage of preparation described in sections 4.1.1, 4.1.3, 4.1.4 or 4.1.6.
- Apply a short length of the yellow stress control tape 20mm over the end of the conductive tube and onto the clear tubing by 10mm. Use some of the yellow tape supplied in the main joint kit.

- Position a short length of the stress control tubing (54/24) over the core end, overlapping the conductive tubes and the yellow stress control mastic by 40mm.

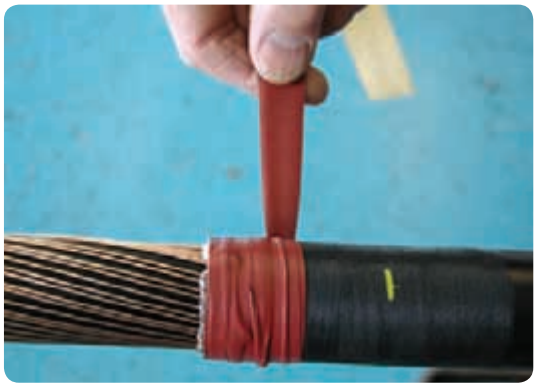
- Shrink the stress control tubing down, starting from the yellow mastic tape and working towards the open core end.

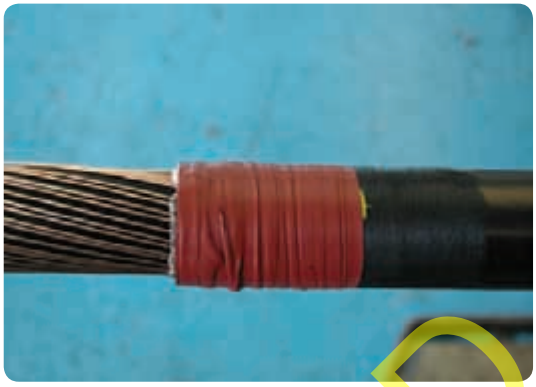
- Wrap one of the red mastic strips provided around each end of the stress control tube 30mm on to the tubing and 10mm on to the core.

### 4.1.9 Single-Core Polymeric Terminations (Indoor and Outdoor)

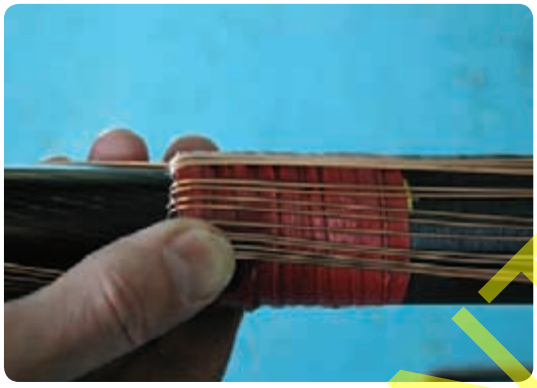
- Follow the cable preparation procedures for polymeric cables as described in section 3.1.
- Use a chinagraph pencil to mark the outer sheath 60mm below the sheath cut position.

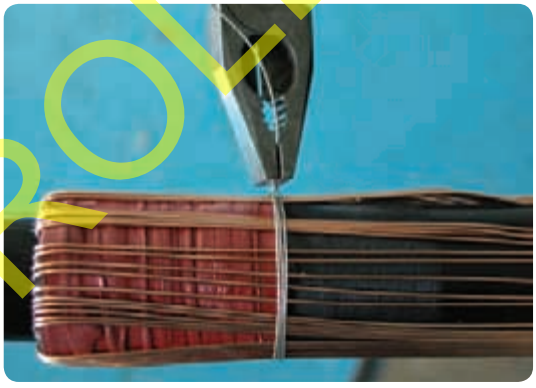
- Wrap one layer of red sealant tape over the cable sheath down to the chinagraph pencil mark.





- Bend back the copper screen wires carefully and lay them onto the mastic tape taking care not to cross over any of the wires. Secure the wires with a wire binder at the 60mm mark.

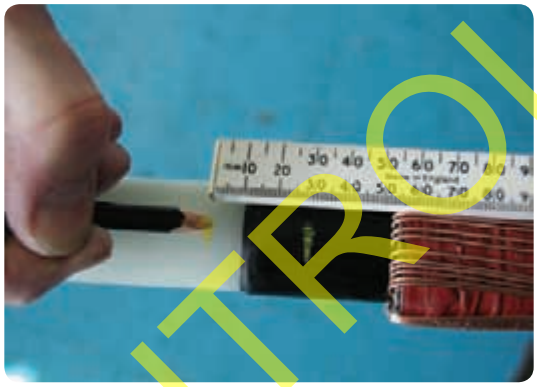




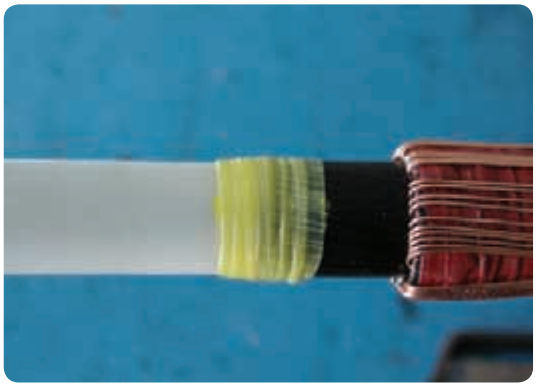
- Make a chinagraph pencil mark onto the core screen 40mm from the sheath cut.

- Remove the core screen down to the 40mm mark using the approved screen stripping tool.

- Make a mark with a chinagraph pencil 20mm on to the core screen and 10mm on to the insulation.

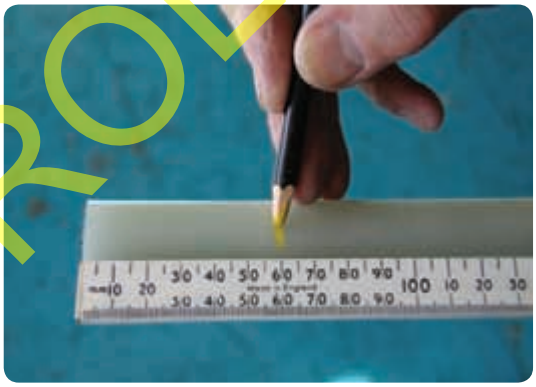


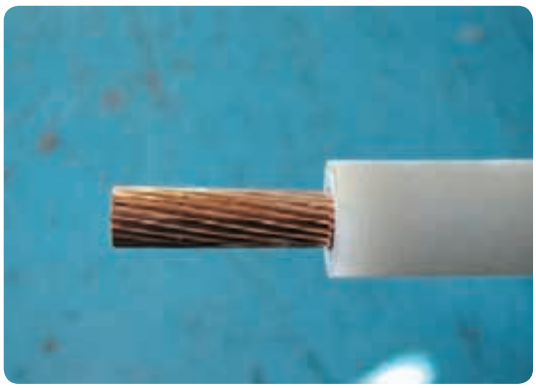
- Remove the release paper and wrap the yellow stress control mastic around the screen cut between the two pencil marks. Stretch the tape to half its original width to achieve a fine thin edge onto the insulation.



- Position the black stress control tubing over the core so that it is level with the outer sheath cut. Shrink the tubing down, starting at the sheath cut end and working upwards. When fully shrunk the tubing should be smooth and wrinkle free.

- Remove the insulation from the core end according to the inner dimension of the cable lug barrel.

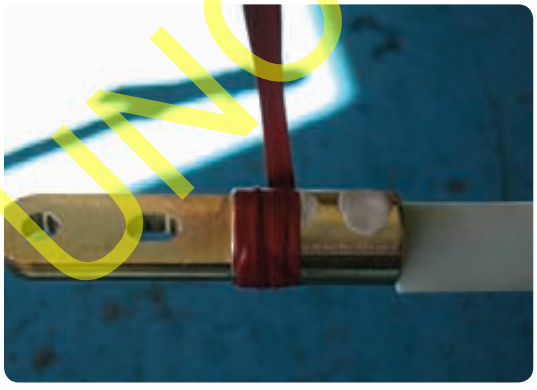




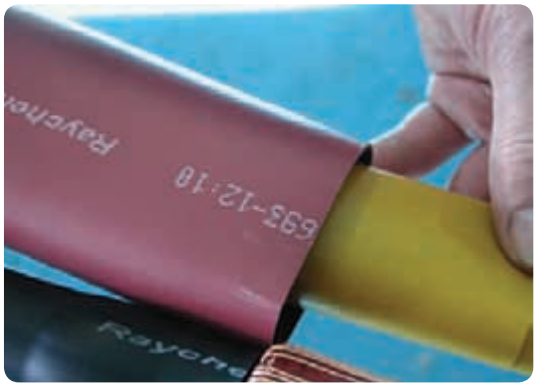
- Fit the cable lug ensuring that the lug butts against the insulation edge and hand tighten the securing bolts.

- Shear off the bolt heads using the approved tools and fill in the indents with the grey clay provided.

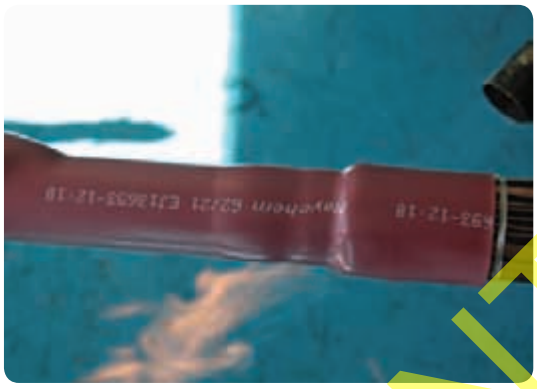
- Wrap the red sealant tape around the lug barrel, overlapping onto the insulation. Build up the diameter difference with the red tape so that a smooth and even profile is achieved.



- Remove the release paper from the red tubing. Place the tubing over the cable end (with the sealant coated end downwards), level with the wire binder.



- Shrink the tubing down starting at the outer sheath end, before working towards the cable lug.

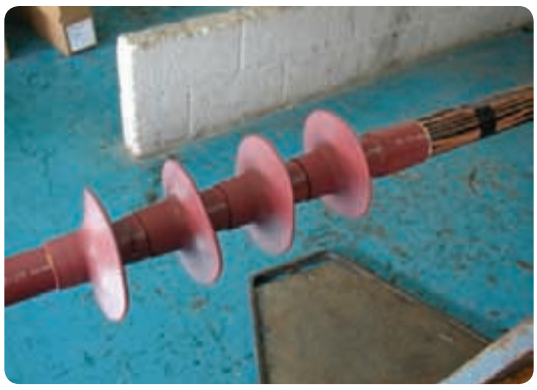


- Cut the tubing back onto the cable lug, level with the top of the main body, if necessary.
- Post-heat the palm of the cable lug until a bead of the sealant appears around the top of the tubing.

- Use a chinagraph pencil to mark the position for the sheds on the tubing at the dimension given in the termination instruction.

- Place two skirts over the cable end and position on the previously made marks. Shrink each shed in place.

- For outdoor terminations there are four skirts to be fitted to each termination. These should be placed and shrunk into position at the measurements indicated in the relevant jointing instruction.



## 4.2 Installing Mechanical Connectors and Lugs

### 4.2.1 Single-Core Polymeric Straight Joints

- The cables will have been prepared up to the point as described in section 3.1.
- Position the combined stress control, screened insulating tubing and outer sealing sleeve over one of the cable ends.

- Remove the insulation as described in section 3.1.3.

- The connector comes with metal inserts to fit small conductors. If the conductor will not fit the connector, discard the insert and use the connector without it.

- Fit the conductors into the connector. The insulation should butt against the end of the connector.

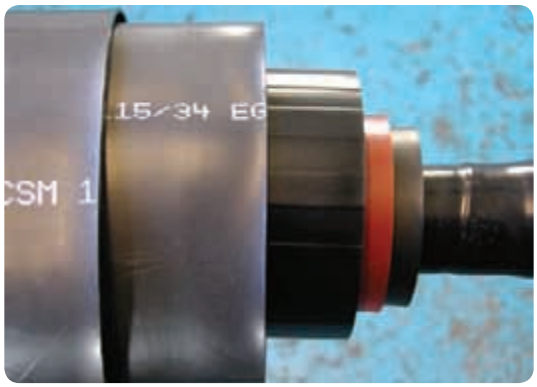
- Using the approved insulated tool to hold the connector, take up the tension on all the bolts equally without shearing them off.

- Continue to tighten and sheer off all the bolts starting with the bolts at each end followed by the central bolts.

- Fill the bolt holes in the connector with the grey clay supplied in the joint kit.

### 4.2.2 Single-Core Transitional Straight Joints

- The cables will have been prepared up to the point as described in sections 3.1 and 3.2.
- Slide the five piece tubing set over the polymeric cable side. Nesting the tube set on the plastic bag wrapping will keep the inside of the tubes clean. The tube set should be placed in the order shown.




**Note** : It is important that the fourth tube (the second largest) is placed within the tube set so that the uncoated inner edge points towards the joint centre.

- Remove the insulation from both cables using the methods described in sections 3.1.3 and 3.2.5.

- The connector is a 'Two Piece' design with the two halves secured together with a central shear bolt. Each connector half has two conductor securing bolts which are also of the shear off type.

- Fit the conductors into the connector. The insulation should butt against each end of the connector.

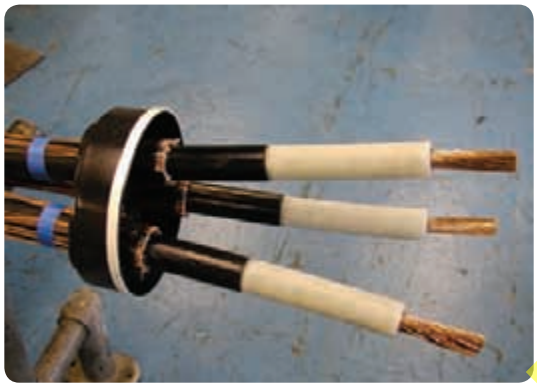
- Using the approved insulated tool to hold the connector, take up the tension on all the bolts equally without shearing them off.

- Continue to tighten and sheer off all the bolts starting with those at each end followed by the central bolt.

- Fill the bolt holes in the connector with the grey clay supplied in the joint kit.

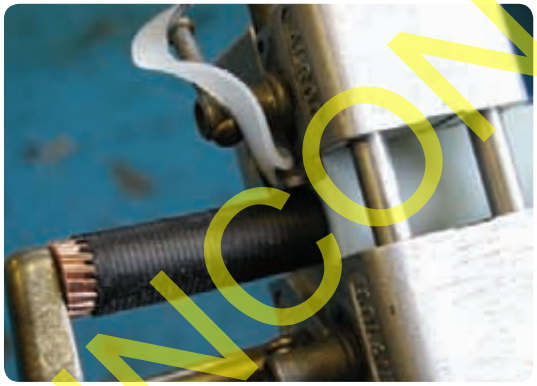
### 4.2.3 Resin Filled Three-Core Trifurcating Joints (Three-Core Paper to 3 x Single-Core Polymeric Cables)

- The cables will have been prepared up to the point as described in section 3.1 and 4.1.3.
- Slide the plastic trifurcating end of the plastic joint box over the single-core cables and position it away from the jointing area.



- Slide the three piece tubing sets over the polymeric cable side. Nesting the tube sets on the plastic bag wrapping to keep the inside of the tubes clean. The tube sets should be placed in the order shown.

- Set the cores in their final jointing position. Check that the conductors have been cut to allow for any connector central moisture block. Remove the insulation from both conductors, sections 3.1.3 and 3.3.7, to the connector insertion depth.



- Insert each end of the core into its respective 'connector half' and finger-tighten the bolts.

- Align and position the two connector halves so that the central fixing bolt can be inserted into the central fixing hole. The use of force for this operation should not be necessary.

- Hold the connector with the approved holding tool and tighten the two bolts on one side until they sheer off.

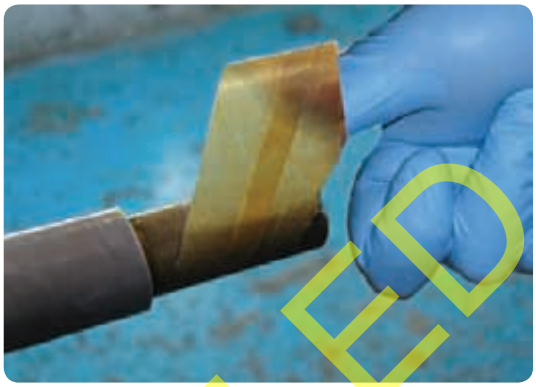
- Repeat the operation on the other side of the connector. Check that the combined tube set is located over the single-core cables and sheer off the central fixing bolt.

- Clean and degrease the connector. Fill the bolt holes with the supplied grey clay to obtain a smooth finish.

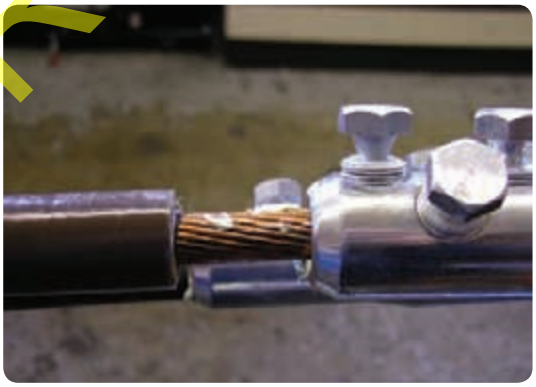
### 4.2.4 Heatshrink Three-Core Transition Straight Joint (Three-Core Paper to 3 x Single-Core Polymeric Cables)

- The cables will have been prepared up to the point as described in sections 3.1 and 4.1.4.
- Slide the outer joint heatshrink sealing breakout over the single-core cables and position it away from the jointing area.

- Slide the four piece tubing set over the polymeric cable side. Nesting the tube set on the plastic bag wrapping will keep the inside of the tubes clean. The tube set should be placed in the order shown.
- Remove the insulation from both cables using the methods described in sections 3.1.3 and 3.3.7.



- Slide the mechanical connector onto the conductor on the paper side of the joint. The connector is fitted with an insert to accommodate smaller section cables; if the cable conductor fits into the connector with the insert in place, use it - if not, remove the insert and use it without.

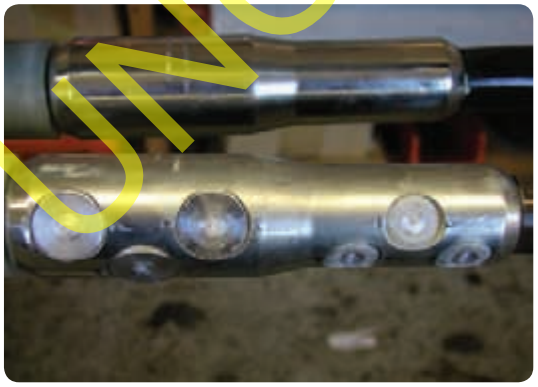


- Check that the connector butts up against the insulation and finger-tighten the bolts.

- Insert the single-core polymeric cables into the connector ensuring that the connector butts up against the insulation and finger-tighten the bolts.

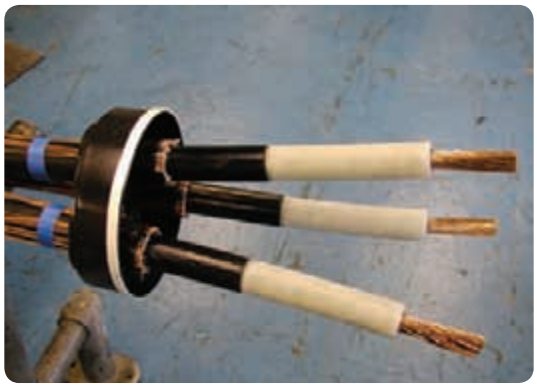
- Hold the connector with the approved holding tool and tighten each bolt half a turn at a time with a socket until it shears off. Start with the bolt nearest the insulation at each end before moving on to the other two bolts, working towards the middle.

- Smooth off any sharp edges from the bolts and then clean and degrease the connector. Fill the bolt holes with the supplied grey clay to obtain a smooth finish.

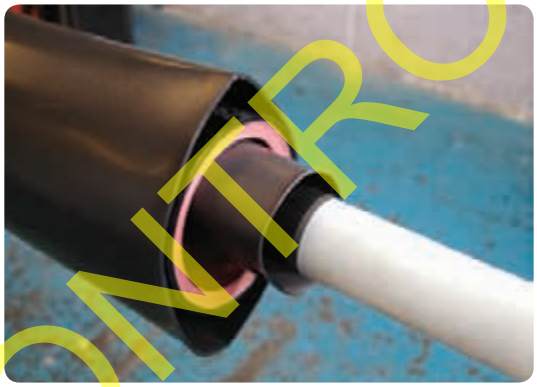


### 4.2.5 HSL Trifurcating Joints (Three-Core HSL to 3 x Single-Core Polymeric Cables)

- The cables will have been prepared up to the point as described in Section 3.1 and 4.1.6.
- Slide the plastic trifurcating end of the plastic joint box over the single-core cables and position it away from the jointing area.



- Position a combined tube set (stress control, insulating tube and screened insulating) over each of the single-core polymeric cables.



- Set the cores in their final jointing position. Check that the conductors have been cut to allow for any connector central moisture block. Remove the insulation from both conductors (3.1.3 and 3.3.7) to the connector insertion depth.

- Insert each end of the core into its respective 'connector half' and finger-tighten the bolts.

- Align and position the two connector halves so that the central fixing bolt can be inserted into the central fixing hole. The use of force for this operation should not be necessary.

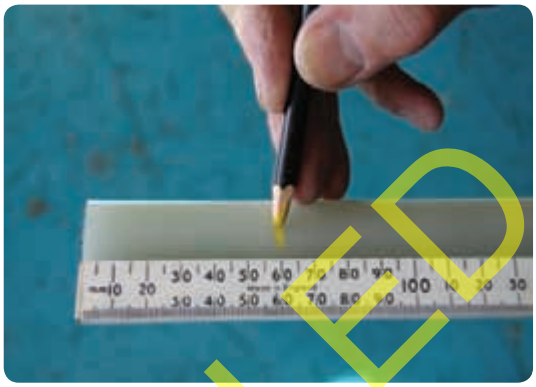
- Hold the connector with the approved holding tool and tighten the two bolts on one side until they sheer off.

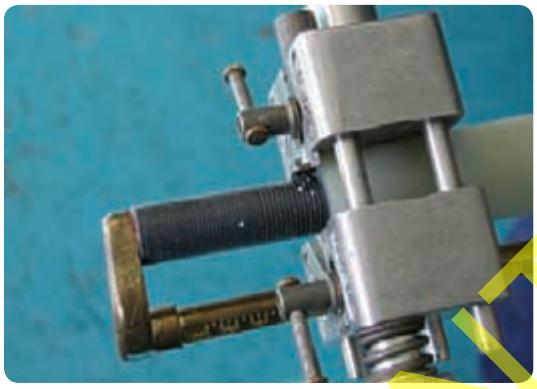
- Repeat the operation on the other side of the connector. Check that the combined tube set is located over the single-core cables and sheer off the central fixing bolt.

- Clean and degrease the connector. Fill the bolt holes with the supplied grey clay to obtain a smooth finish.

### 4.2.6 Mechanical Lugs for Indoor and Outdoor Terminations

- Follow the cable preparation procedures for polymeric cables in sections 3.1.1 to 3.1.3 before installing any mechanical lugs.
- Each kit comes with the correct size and type of lug for each termination. Remove the conductor insulation to the insertion depth of the lug.





- Place the lug over the conductor so that the bottom of the barrel butts up against the core insulation.

- Tighten the bolts by hand and check that the palm holes line up with their respective connection point.
- Tighten the bolts until the bolt heads shear off.

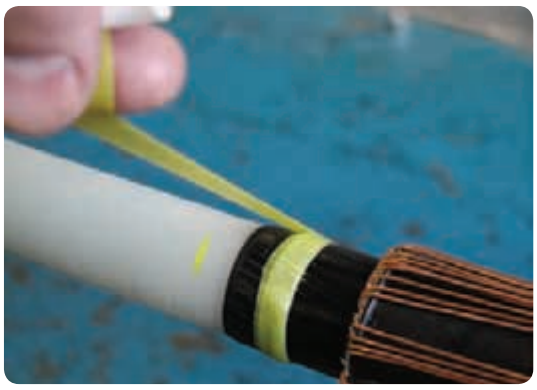
## 4.3 Installing Connector Stress Control and Heatshrink Insulation

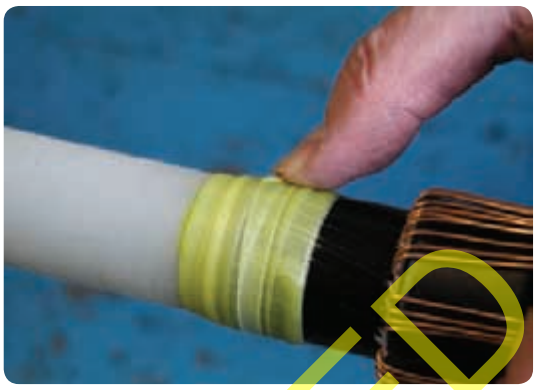
### 4.3.1 Single-Core Polymeric Straight Joints

- Fit the connector up to the point as described in section 4.2.1.
- Use a chinagraph pencil to mark the black insulation screen of both cables 20mm from the screen cut.

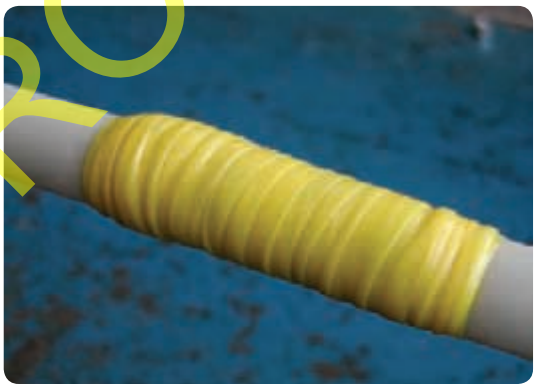
- Make a second chinagraph pencil mark on the insulation 10mm from the screen cut.

- Stretch one of the short yellow stress control mastic supplied in the kit to half its original width. Wrap it around the core screen and insulation between the two chinagraph pencil marks. Repeat for the other cable side.





- Use the long strip of yellow stress control mastic to wrap the mastic around the connector with a 50% overlap, stretching the mastic to about half its original width. Cover all the connector area and overlap to the insulation on each side of the connector by 5mm. Make sure there is a smooth transition from the connector onto the insulation.



- Position the black stress control tube centrally over the connector area. Each end of the tube should extend beyond the screen termination points of each cable. Shrink the stress control tubing down, starting in the centre and working towards each end in turn.

- Position the screened insulating red and black tube centrally over the stress control tube and start shrinking the sleeve at the centre position using equal heat over the whole surface.
- When the tubing is properly shrunk, the ridges on the outer black layer of the tube should no longer be visible.

- Continue to shrink the tube from the centre to within 50mm of one end.

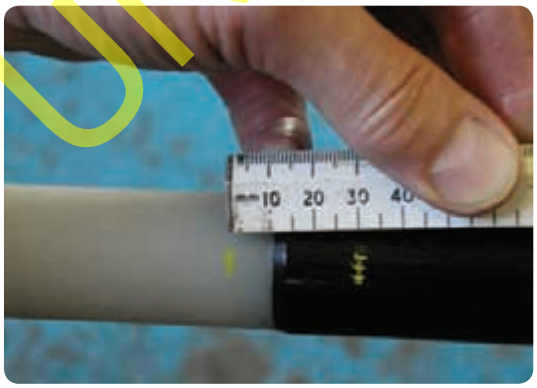

- Remove the heat from that end and start shrinking from the middle again towards the other end of the tubing. Stop again 50mm from the end. This ensures that air inside the tube is expelled as the tube shrinks.

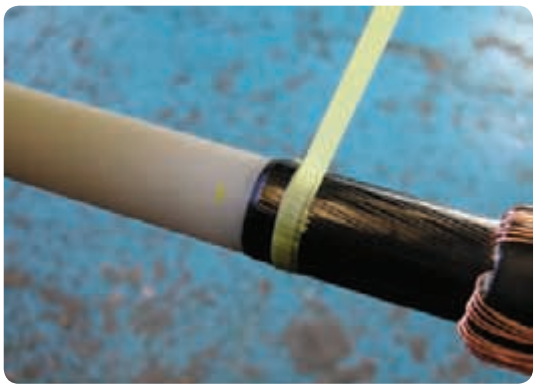
- Return to each tube end in turn to complete the shrinking process completely.

### 4.3.2 Single-Core Transition Straight Joints

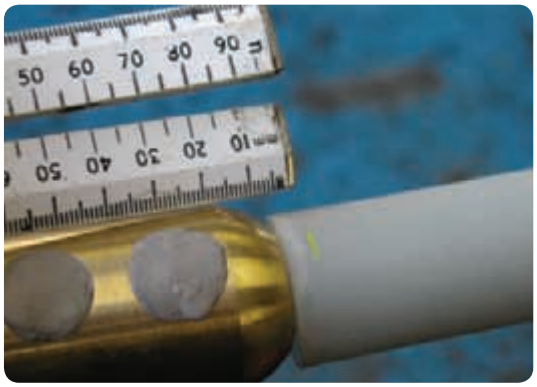
- Fit the connector up to the point as described in section 4.2.2.
- Wrap a short piece of the yellow stress control mastic around the paper cable core at the edge of the short black conducting sleeve. Start 20mm on the conducting tube, continuing for 10mm onto the clear barrier tube.


- Wrap a shorter piece of the yellow stress control mastic around the polymeric screen, starting 20mm from the screen edge and continuing for 10mm on to the insulation. Stretch the tape to half its original width during the taping process.



- Use the long strips of yellow stress control mastic to wrap the mastic around the connector with a 50% overlap, stretching it to about half its original width. Cover the connector area and overlap on to the insulation each side of the connector by 5mm. Make sure a minimum coverage of 2mm is achieved over the connector area.





- Pull the black stress control tubing from inside the nested tube set and position it centrally over the connector area, leaving a 20mm gap between the over sheath and the tubing end.

- Shrink the stress control tubing down starting in the centre, before working towards each end in turn. When finished the tubing should be fully shrunk and wrinkle free.

- Wrap a piece of red sealant mastic around each end of the stress control tubing. Start from 10mm on the stress control tubing and extend for 10mm onto the core screen at both ends.

- Pull the red insulating tubing from inside the nested tube set and position it centrally over the stress control tube. Start shrinking in the centre before working towards each end in turn.

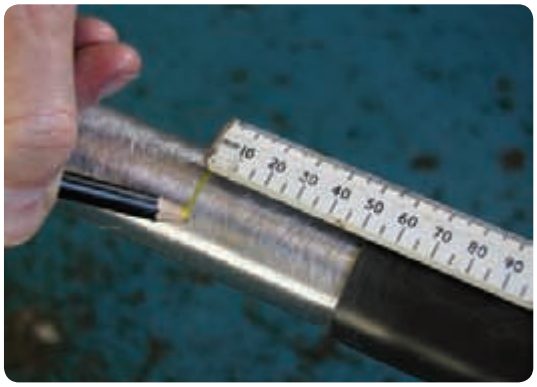
**Note**: Continue on to the next step while the red insulating tubing is still hot.

- Pull the black and red screened insulating tubing centrally over the red insulating tube and start shrinking the sleeve at the centre position using equal heat over the whole surface. When the tubing is properly shrunk, the ridges on the outer black layer of the tube should no longer be visible and the tube can no longer be moved.

- Continue to shrink the tube from the centre to within 50mm of one end.

- Remove the heat from that end and start shrinking from the middle again towards the other end of the tubing. Stop again 50mm from the end. This ensures air inside the tube is expelled as the tube shrinks.
- Return to each tube end in turn to complete the shrinking process completely.

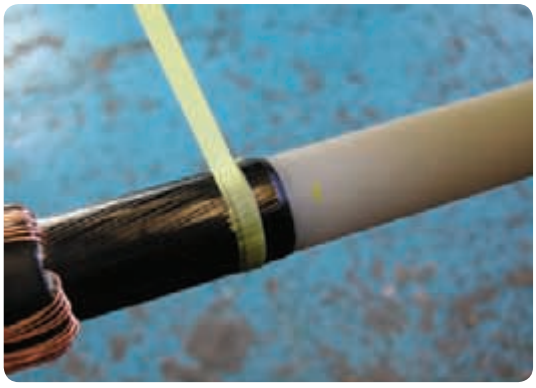
- Pull the black compression sealing sleeve across the joint to the paper cable side and place it so that at least 50mm of lead sheath is still visible.



- Shrink the tubing down, starting on the tube set end and working towards the lead sheath. Once completed there should be approximately 50mm of lead sheath still exposed.

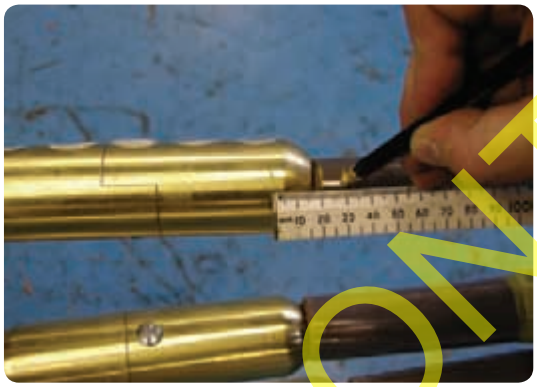
### 4.3.3 Resin Filled Three-Core Transition Straight Joints (Three-Core Paper to Single-Core Polymeric Cables)

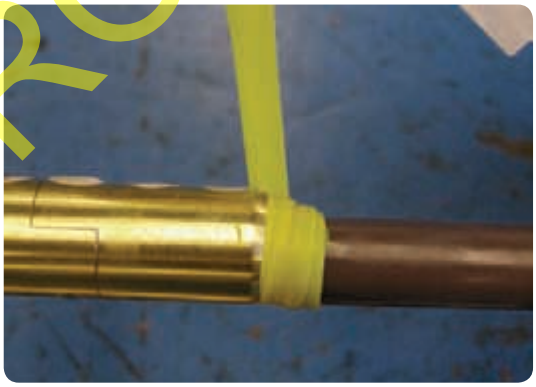
- Fit the connector up to the point as described in section 4.2.3.
- Remove the release paper from one of the short yellow stress control mastic strips and wrap it around the polymeric core screen, starting 20mm from the screen edge and continue onto the insulation for 10mm. Stretch the tape to half its original width to achieve a fine thin edge on the insulation.



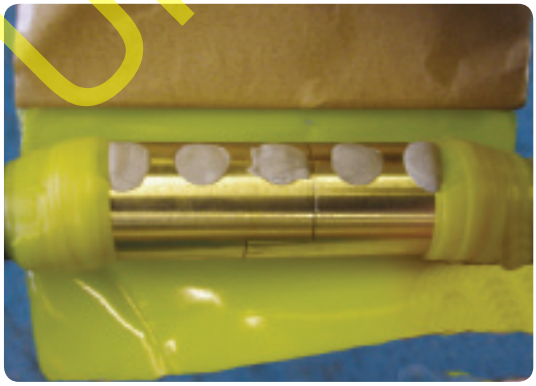
- Repeat the exercise on the paper cable core, wrapping the yellow stress control mastic around the edge of the conductive tubing. Cover 20mm of the conductive tubing and continue on to the clear tubing for 10mm.

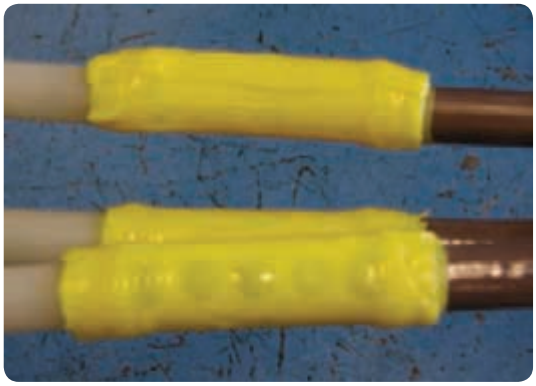
- Ensure that the bolt holes are filled with the supplied grey clay to leave a smooth profile. Use a long piece of the yellow stress control mastic to fill the ends of the connector and the insulation cut back continuing 10mm on to the insulation, and 20mm on to the connector. If there is a step between the body of the connector and the cable insulation apply yellow stress control mastic to form a smooth the profile.





- Remove the release paper from the yellow stress control mastic patch and wrap it centrally around the connector, taking care to exclude any trapped air as it is applied. When finished the patch should be smooth and wrinkle free.

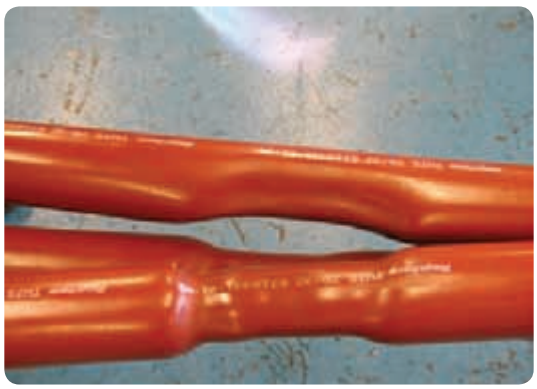




- Slide the stress control tubing from inside the nested tube set and position it centrally over the connector area. Make sure that the overlap over each taped screen edge is equal. Shrink the tubing starting in the centre and working towards each end in turn.

- Remove the release paper from one length of the red sealant tape and wrap it around the end of the stress control tube. Overlap the tape on to the tube by 20mm and by 10mm on to the core.

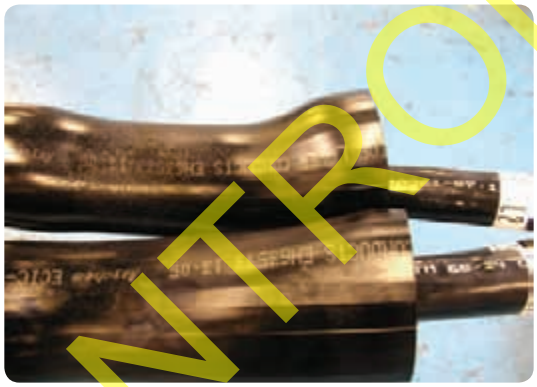
- Pull the red insulating tubes from the tube sets and centrally position them over the stress control tubes. Shrink the tubing starting in the centre before working towards each end in turn. When complete the tube should be smooth and wrinkle free.



**Note**: Continue with the next step while the red insulating tubing is still hot.

- Position the screened red and black insulating tubes centrally over the red insulating tubes. Start shrinking the sleeves at the centre position using equal heat over the whole surface. When the tubing is properly shrunk, the ridges on the outer black layer of each tube should no longer be visible and the tubes can no longer be moved.

- Continue to shrink the tube from the centre to within 50mm of one end.

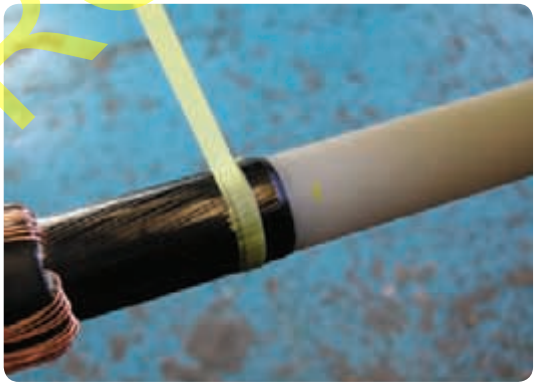


- Remove the heat from that end and start shrinking from the middle again towards the other end of the tubing. Stop again 50mm from the end. This ensures air inside the tube is expelled as the tube shrinks.

- Return to each tube end in turn to complete the shrinking process completely.

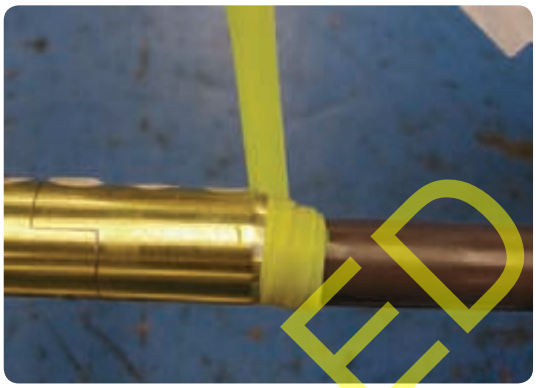
### 4.3.4 Heatshrink Three-Core Transition Straight Joints (Three-Core PILC to Single-Core Polymeric)

- Fit the connector up to the point as described in section 4.2.4.
- Remove the release paper from one of the short yellow stress control mastic strips and wrap it around the polymeric core screen, starting 20mm from the screen edge and continue onto the insulation for 10mm. Stretch the tape to half its original width to achieve a fine thin edge on the insulation.

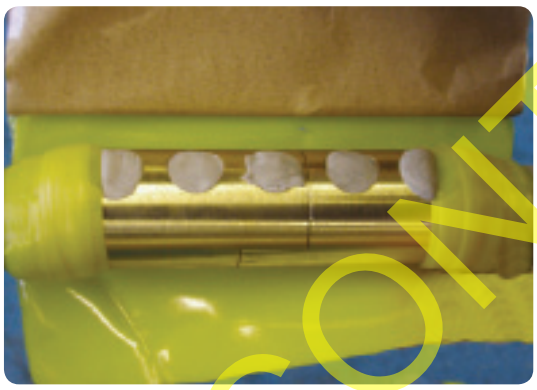


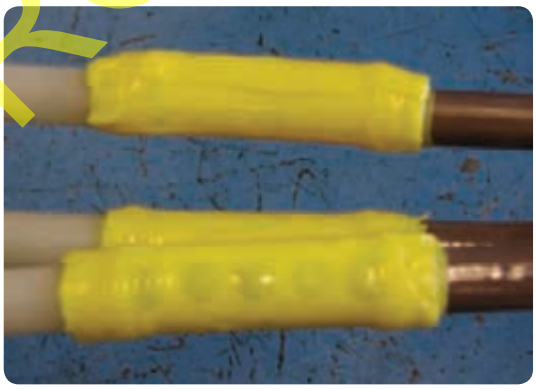
- Repeat the exercise on the paper cable core, wrapping the yellow mastic around the edge of the conductive tubing. Cover 20mm of the conductive tubing and continue on to the clear tubing for 10mm.

- Check that the bolt holes are filled with the supplied clay to leave a smooth profile. Using a long piece of the yellow stress control mastic, fill the ends of the connectors and the insulation cut backs, continuing 10mm on to the insulation and 20mm on to the connector. If there is a step between the body of the connector and the cable insulation apply yellow stress control mastic to form a profile.



- Remove the release paper from one of the yellow stress control mastic patch and wrap it centrally around the connector, taking care to exclude the air as it is wrapped. When finished the patch should be smooth and wrinkle free. Repeat the process with all three connectors.

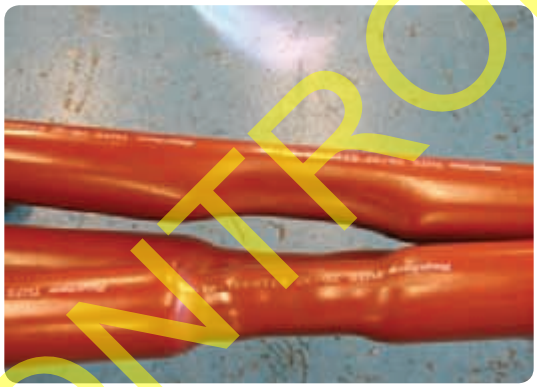




- Slide the stress control tubes from inside the nested tube sets and position them centrally over each connector ensuring that the overlap over each taped screen edge is equal. Shrink the tubing starting in the centre before working towards each end in turn.

- Remove the release paper from one length of the red sealant mastic tape and wrap it around the end of the stress control tube. Overlap the tape on to the tube by 20mm and by 10mm on to the core.


- Pull the red insulating tubes from the tube sets and centrally position them over the stress control tubes. Shrink the tubing starting in the centre before working towards each end in turn. When complete the tube should be smooth and wrinkle free.



**Note**: Continue with the next step while the red insulating tubes are still hot.

- Pull the screened red and black insulating tubes centrally over the red insulating tubes and start shrinking the sleeves at the centre position using equal heat over the whole surface. When the tubes are properly shrunk, the ridges on the outer black layer of the tubes should no longer be visible and the tubes can no longer be moved.

- Continue to shrink the tubes from the centre to within 50mm of one end.

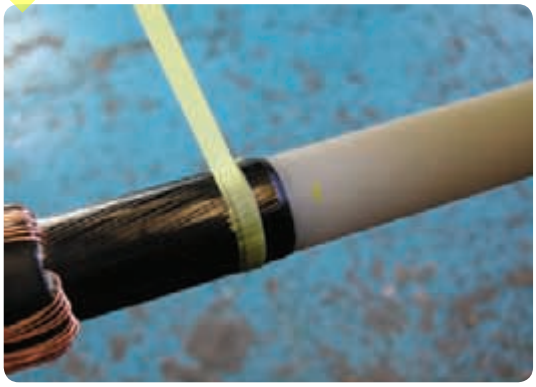
- Remove the heat from that end and start shrinking from the middle towards the other end of the tubes. Stop 50mm from the end. This ensures air inside the tube is expelled as the tube shrinks.

- Return to each tube end in turn to complete the shrinking process completely.

- Position the three compression sleeves over the paper end of the joint, so that they equally overlap the red and black insulation tubes and the core tubes. The uncoated end of the compression sleeve should be positioned towards the centre of the joint. Shrink in place starting from the centre of the tubes towards the centre of the joint before finally shrinking from the centre towards the crutch.

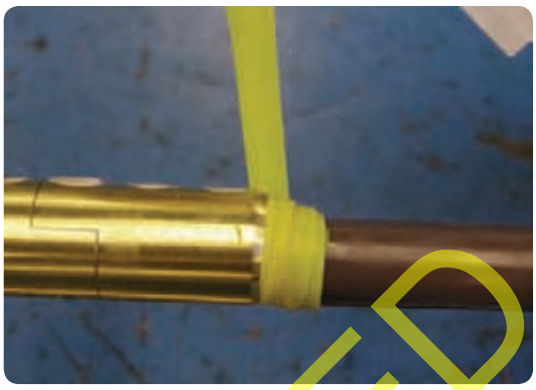
### 4.3.5 HSL Trifurcating Joints (Three-Core HSL to 3 x Single-Core Polymeric Cables)

- Fit the connector up to the point as described in 4.2.5.
- Remove the release paper from one of the short yellow stress control mastic strips and wrap it around the polymeric core screen, starting 20mm from the screen edge and continue onto the insulation for 10mm. Stretch the tape to half its original width to achieve a fine thin edge on the insulation.

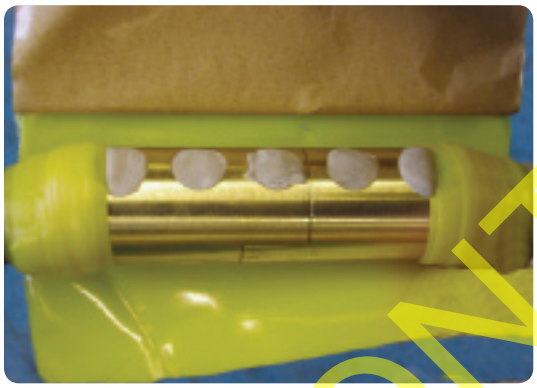


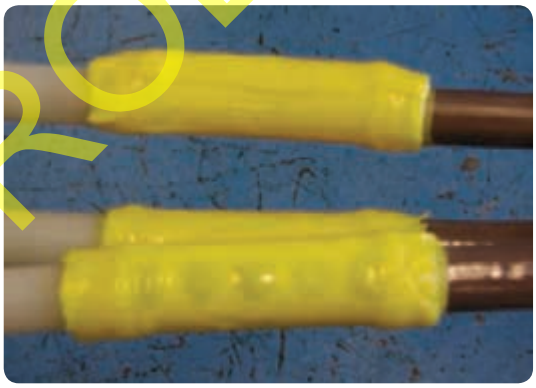
- Repeat this on the paper cable core, wrapping the yellow mastic around the edge of the conductive tubing. Cover 20mm of the conductive tubing and continue on to the clear tubing for 10mm.

- Check that the bolt holes are filled with the supplied grey clay to leave a smooth profile. Use a long piece of the yellow stress control mastic to cover both ends of the connector, 20mm on the connector and 10mm onto the insulation.



- Remove the release paper from the yellow stress control mastic patch and wrap it centrally around the connector, taking care to exclude any trapped air as it is applied. When finished the patch should be smooth and wrinkle free.

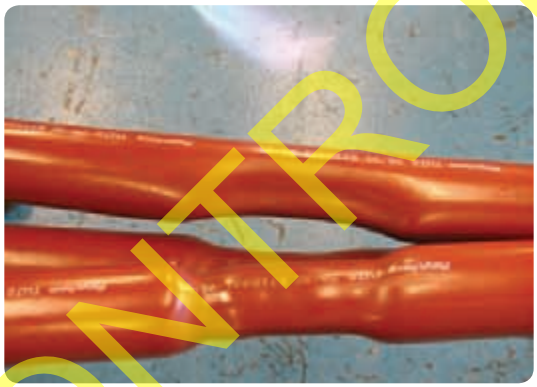




- Slide the stress control tubes from inside the nested tube sets and position them centrally over the connectors ensuring that the overlap over each taped screen edge is equal. Shrink the tubes starting in the centre before working towards each end in turn.

- Remove the release paper from one length of the red sealant mastic tape and wrap it around both ends of the stress control tube. Overlap the tape on to the tube by 20mm and by 10mm on to the core.


- Pull the red insulating tubes from the tube sets and centrally position them over the stress control tubes. Shrink the tubes starting in the centre before working towards each end in turn. When complete the tubes should be smooth and wrinkle free.

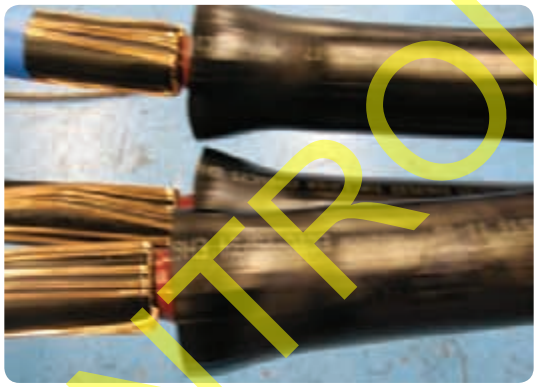


**Note**: Continue with the next step while the red insulating tubes are still hot.

- Pull the screened black and red insulating tubes centrally over the red insulating tubes and start shrinking at the centre position using equal heat over the whole surface. When the tubes are properly shrunk, the ridges on the outer black layer of the tubes should no longer be visible and the tubes can no longer be moved.

- Continue to shrink the tubes from the centre to within 50mm of one end.

- Remove the heat from that end and start shrinking from the middle again towards the other end of the tubes. Stop again 50mm from the end. This ensures air inside the tube is expelled as the tube shrinks.

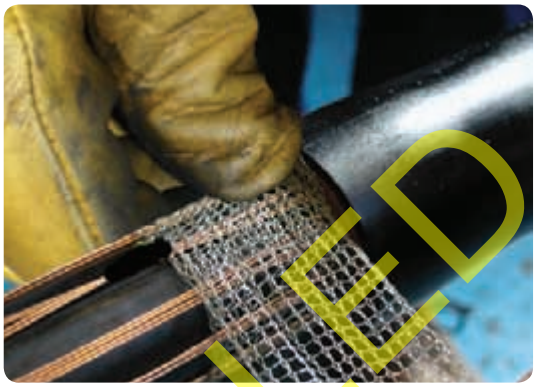


- Return to each tube end in turn to complete the shrinking process completely.

## 4.4 Installing Mechanical Earth Bonds and Associated Components

### 4.4.1 Single-Core Polymeric Straight Joints

- Complete the procedures for insulating the connector as described in 4.3.1.
- Wrap the joint with one layer of the tinned copper mesh ensuring there is a 50mm overlap onto the oversheath of the cable side with the short shield wires.



- Continue across the whole joint with the tinned copper mesh at a 50% overlap and secure on to the opposite joint side.

- On the cable side with the long screen wires, bend the screen wires back across the joint and form them into two separate conductors. On the cable side with the short screen wires, repeat the same exercise and fold the gathered wires back towards the joint centre.

- Gather the wires together and cut them centrally above the tinned copper mesh overlapping the cable sheath. Install the copper screen wire conductors into their respective connector and tighten the bolts until the heads shear off.

- Wrap a second layer of the copper mesh around the joint, as before, so that the whole area is completely covered including the mechanical screen connectors.

- Clean and degrease the outer sheaths of both cables for 150mm from the sheath cut. Slide the large outer sealing sleeve centrally over the joint area.

- Start shrinking the tube at the centre before working towards each end in turn. Allow to cool before moving or backfilling the joint.

### 4.4.2 Single-Core Transition Joints

- Complete the procedures for insulating the connector as described in 4.3.2.
- Wrap two layers of tinned copper mesh at 50% overlap over the joint from the lead sheath on the paper cable to the over-sheath cut on the polymeric cable.

- Fold back the copper screen wires over the joint and form them into an earth lead except for the area over the lead sheath. At this point open up the wires and place them directly on to the tinned copper mesh. Wrap the roll spring over the screen wires and twist up tight.

- Completely cover the roll spring with two layers of PVC tape.

- Clean, degrease and abrade the outer sheaths for 150mm from the sheath cuts. Slide the large outer sealing sleeve over the joint area and start shrinking the tube at the centre before working towards each end in turn.

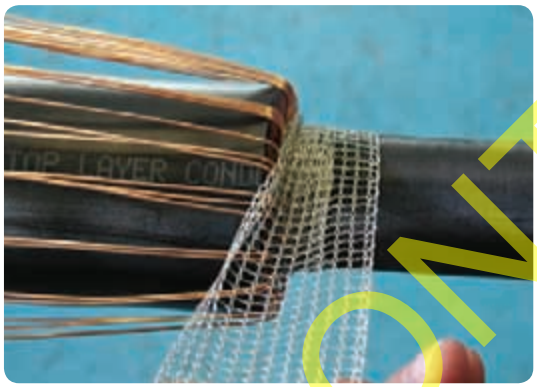


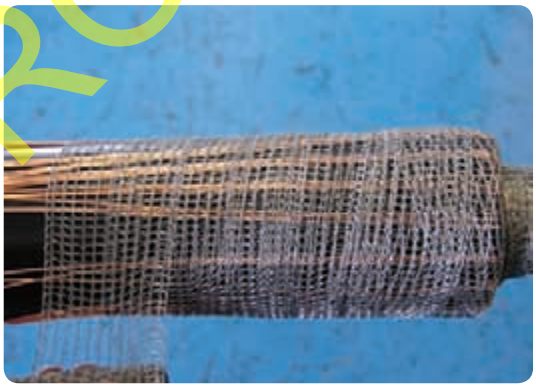
- Allow the joint to cool before moving or backfilling.

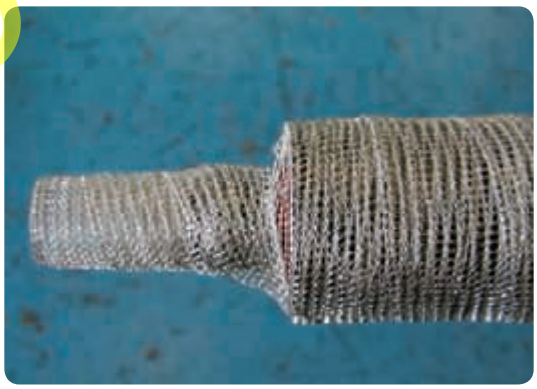
### 4.4.3 Polymeric Pot Ends

- Complete the steps in section 4.1.2.
- Lay the copper screen wires back over onto the screened black and red insulating sleeve and distribute them around the circumference evenly.

- Wrap the tinned tinned copper mesh with a 50% overlap around the pot end, starting at the outer sheath and continuing up onto the copper screen wires, before covering the insulating rod.

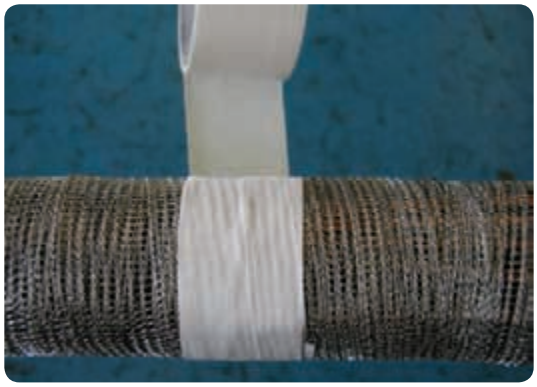






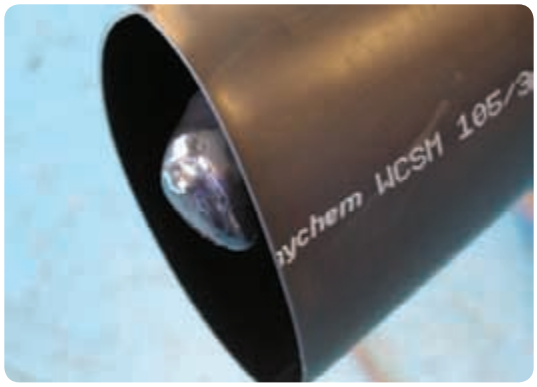
**Note**: The stress control tubing and the rod end must be in contact with the tinned copper mesh.

- Cover the ends of the copper screen wires under the tinned copper mesh with two layers of fabric tape.



- Place the heatshrink end cap over the pot end and shrink it into place. Start at the closed end before working towards the cable sheath. During the shrinking process carefully push the closed end of the cap against the insulating end with an appropriate tool.

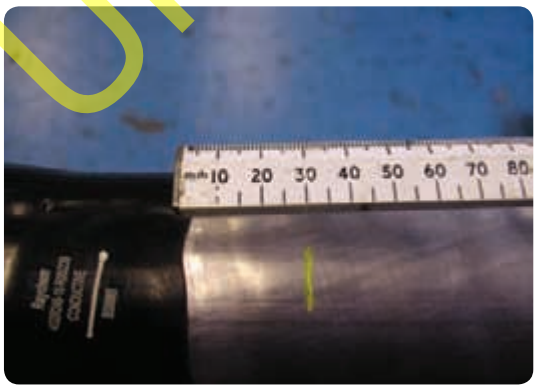
- Check that the over-sheath is clean and degreased. Position the outer sealing sleeve over the pot end assembly so that it lines up with the end of the end cap.

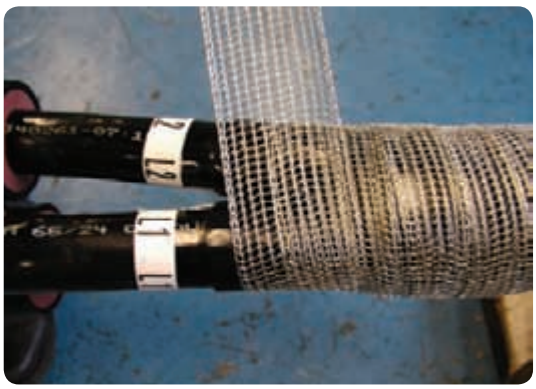


- Shrink the tubing down, starting at the centre working towards each end in turn. Do not move or backfill until the pot end has cooled.

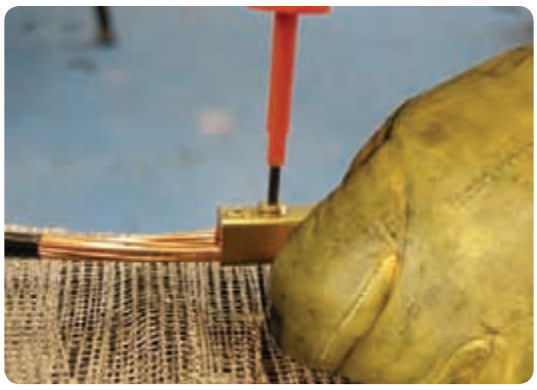
### 4.4.4 Resin Filled Three-Core Transition Straight Joints (Three-Core Paper to 3 x Single-Core Polymeric Cables)

- Complete the procedures for installing the connector insulation in section 4.3.3.
- Pull the cores together as closely as possible and wrap one layer of tinned copper mesh around the joint with a 50% overlap. Continue on to the lead sheath for 30mm and up to the screen wires on the opposite joint side.

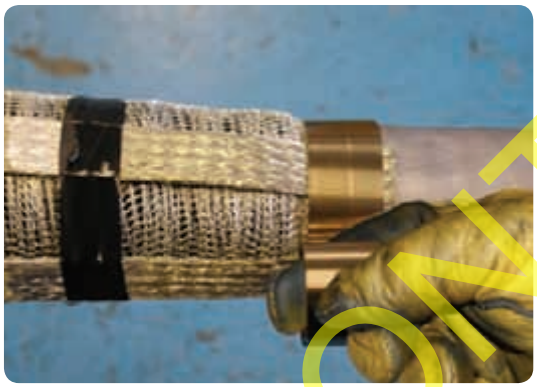


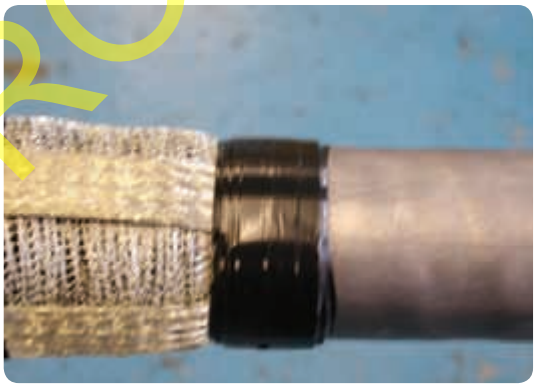



- Lay the copper wire screens back across the joint and form them into three separate earth conductors. Connect the copper screen wires to each of the three earth braids using the mechanical connectors provided.

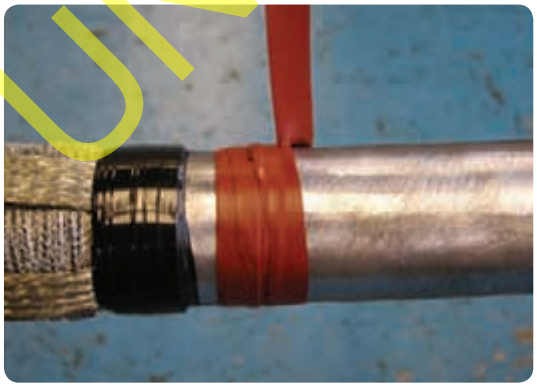


- Position the three earth braids evenly around the lead sheath area on top of the tinned copper mesh. Connect the three earth braids to the lead sheath using a large roll spring.
- Wrap the roll spring over the braids and twist the spring up tightly. Cover the roll spring with two layers of PVC tape.



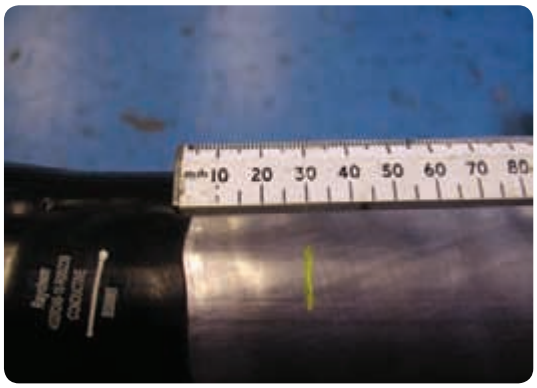


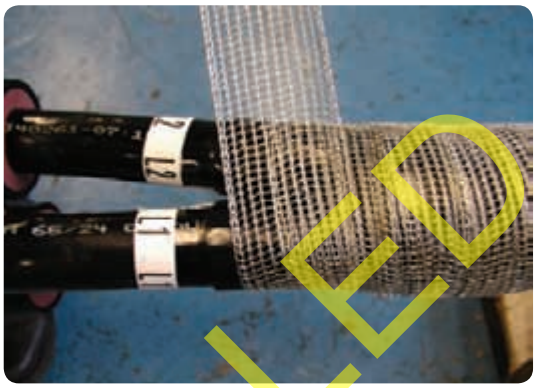
- Wrap the remaining exposed lead sheath with the strips of red sealant tape. **This is an important moisture seal. Do not leave out.**



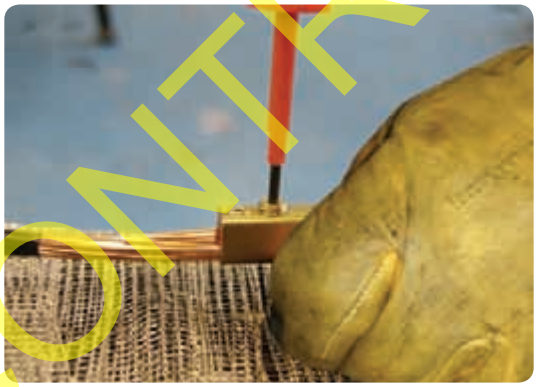
### 4.4.5 Heatshrink Three-Core Transition Straight Joints (Three-Core Paper to Single-Core Polymeric)

- Complete the procedures for installing the connector insulation in section 4.3.4.
- Pull the cores together as closely as possible and wrap one layer of tinned copper mesh around the joint with a 50% overlap. Continue on to the lead sheath for 30mm and up to the screen wires on the opposite joint side.

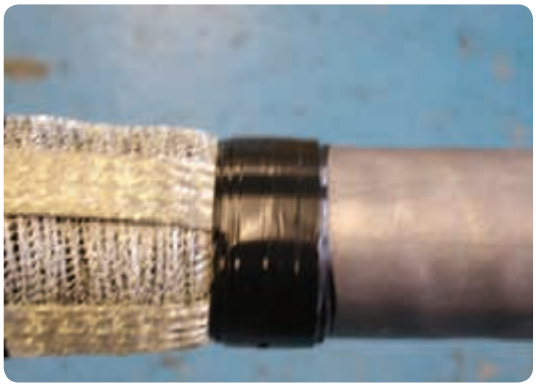


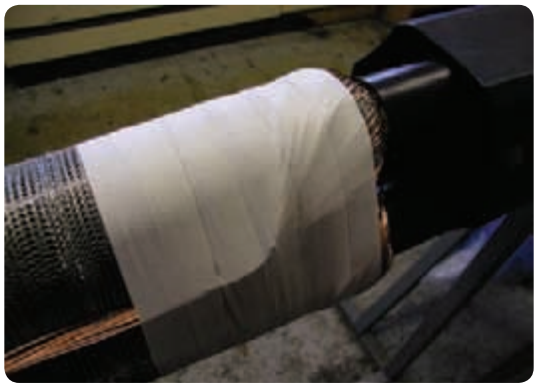
- Lay the screen wires back across the joint and form them into three separate earth conductors. Connect the copper wire screens to the three earth braids using the mechanical connectors provided.



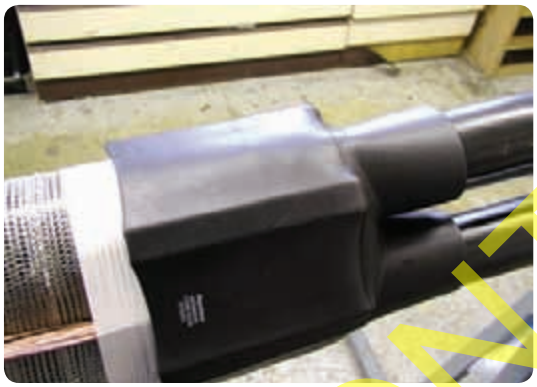
- Lay the three earth leads evenly around the lead sheath on top of the tinned copper mesh. Connect the three earth braids to the lead sheath using a large roll spring. Wrap the roll spring over the braids and twist the spring up tightly. Cover the spring with two layers of PVC tape.

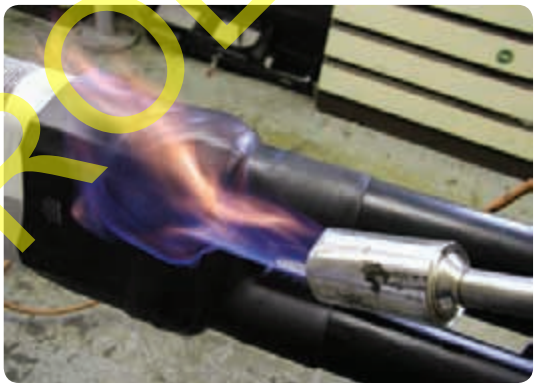


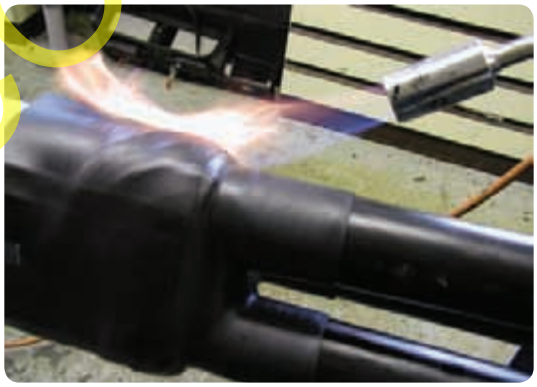
- Apply one half lap layer of white fabric tape over the single-core polymeric end of the joint for a distance of 150mm from the cable oversheath to protect the tinned copper mesh tape from the heat generated by shrinking the Three-Core breakout.



- Pull the heatshrink breakout back over the joint as far as it will go and shrink in place, starting with the turrets before moving on to the main body.







- Wrap the remaining exposed lead sheath with the strip of black mastic sealant tape. This is an important moisture seal. Do not leave out.

- Position the wraparound heatshrink joint sleeve around the joint and connect the two ends together using the maetal channel and the metal joining clip.

- Shrink the wraparound sleeve in place, starting at the middle before moving towards each end in turn. The green paint on the surface of the sleeve should disappear when the tube is correctly shrunk.

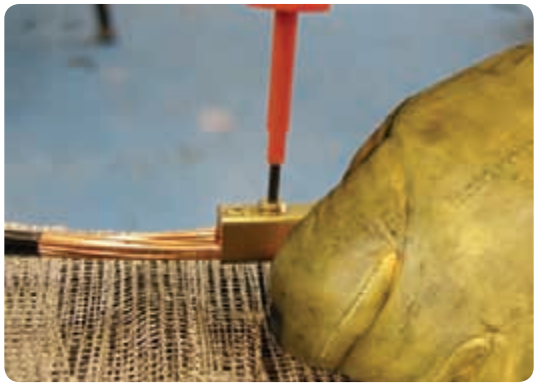
- Extra heat should be applied to the metal channel until the white marker line can be clearly seen under it.

- Do not move or backfill until the joint has completely cooled.

### 4.4.6 HSL Trifurcating Joints (Three-Core HSL to 3 x Single-Core Polymeric Cables)

- Complete the procedures for installing the connector insulation in section 4.3.5.
- Wrap one layer of tinned copper mesh with a 50% overlap over each insulated core continuing across the jointed cores from the sheath cut on the polymeric cables. Finish 50mm on to the lead sheaths.

- Lay the copper screen wires back across the joint and form them into three separate earth conductors. Connect the copper screen wires to each of three earth braids using mechanical connectors provided in the kit.

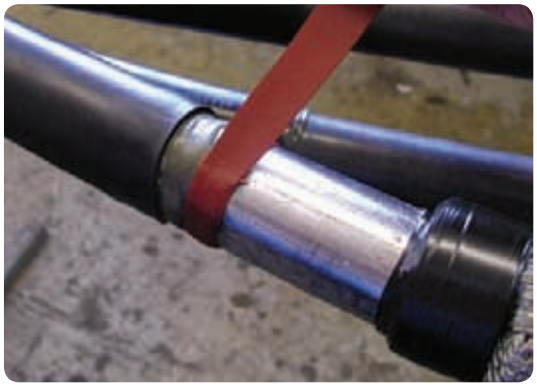


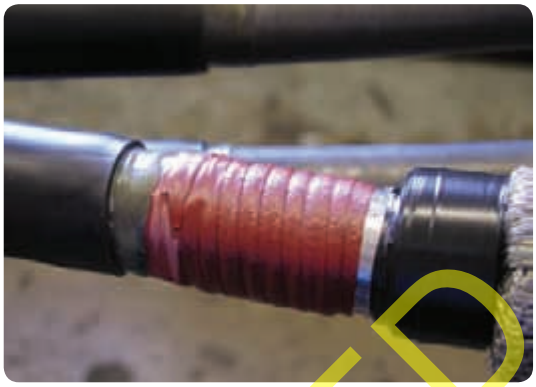
- Connect the each earth braids to each of the individul lead sheaths using a two turns of the roll springs.

- Turn the end of the earth braids back over the two turns of the roll spring ensuring that they are flat and even. Wrap the remainder of the spring length over the braids and twist the spring up tightly.

- Cover the roll springs with two layers of PVC tape.

- Wrap the remaining exposed lead sheaths with the strips of red sealant tape. **This is an important moisture seal. Do not leave out.**





### 4.4.7 Connection of Screen Wires on Indoor and Outdoor Terminations

- Complete the procedures for installing the terminations described in section 4.1.8.
- Connect the screen wires to the Earthing stud or position provided (outdoor terminations) as applicable for the geometry of the apparatus.

### 4.4.8 Fitting Plastic Joint Boxes (Trifurcating Joints Only)

- Trim off the ends of the joint box supplied with the kit, so that it will fit over the cables entering the box.
- Using the box as a guide, offer it up to the cable and mark the stand off positions of the mouldings with a chinagraph pencil.

- Remove the backing from the rubber patches supplied in the kit and apply centrally (over the previously made marks) with the sticky side out.

- Place the two halves of the joint shell over the joint and clip the two halves together with the clips provided. Check enough clips are used to stop the resin leaking out when it is poured in.

- Tape the joint box to the incoming cable with PVC or another suitable tape. If large gaps are left when the shell is fitted it may be necessary to pack the ends of the joint shell out with the clay pack supplied in some kits.

- For extra security, run a length of PVC tape down the seams of the joint shell and fit the plastic lid.

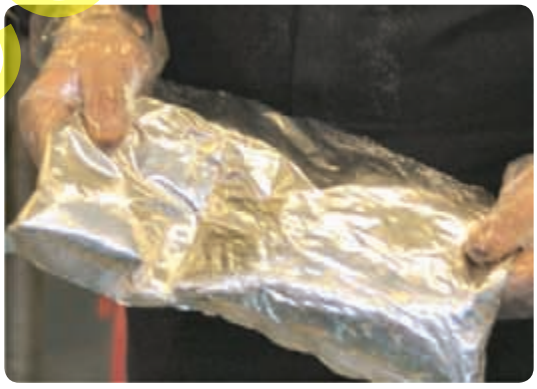
### 4.4.9 Mixing and Installation of Polyurethane Resin

- All 33kV joints should be filled with 3-part polyurethane resin. Check that the correct Personal Protective Equipment is worn at all times and the resin is not mixed in a confined space.
- Check the label on the bucket to ensure that the resin has not passed the use by date.

- Empty the contents of the bucket and check for any damage to the packaging.

- Pick up the foil bag containing the resin and hardener and apply pressure to the large resin pouch so that the resin breaks the seal between the two sections and mixes with the hardener.

- Mix the contents of bag by kneading the foil bag for a minimum of two minutes.



- Carefully cut one of the corners off the foil bag and pour all the contents in to the supplied plastic bucket.

- Pour approximately half of the sand supplied in the plastic bag into the bucket and stir until it is thoroughly mixed into the resin.

- Pour the rest of the sand into the bucket and mix until no raw sand is visible and the resin has no lumps in it.

- Pour the mixed resin into the joint shell.