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**Specification – Supply and Installation of Cable Jointing Material for the Jointing and Repair of PVC Signal and Power Cable**

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## **About This Standard**

This Specification describes the general requirements for the supply and installation of cable jointing material for the jointing and repair of PVC cables for signalling applications within the Australian Rail Track Corporation of NSW signalling system.

## Document History

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## 1. Introduction

This specification describes the general requirements for the supply and installation of cable jointing material for the jointing and repair of PVC cables for signalling applications within the Australian Rail Track Corporation of NSW signalling system.

## 2. Cable Jointing Materials

### 2.1. Closure System for Multicore Signal Cable

Installation instructions are detailed in Appendix B.

The closure system for jointing signalling cable, 4 core to 63 core, shall be Raychem XAGA 530, or direct technical equivalent. This closure will be used in conjunction with Raychem RSS joint filling compound, or direct technical equivalent.

To cover the range of cables available, 2 different sizes of closures will be necessary. These two sizes shall be XAGA 530 43/8-300 SRA1 (4 core to 15 core) and XAGA 530 75/15-400 SRA2 (16 core to 63 core) or direct technical equivalents. Both closures are detailed on Drawings No. M08-802 and M08-803.

Conductors shall be joined by approved procedure, i.e. standard crimp sleeves and crimping tool, as described in Section 7.

2.1.1 Closure System. The system shall consist of a reinforced, heat shrinkable, wraparound sleeve combined with a supporting liner. The sleeve shall be secured around the joint by means of a flexible stainless steel channel and installed with gas torch.

The sleeve material shall be reinforced composite laminate with an integral metal barrier and meet the following criteria: Temporary and permanent installation indicators shall exist so as to assist the installer in assessing the correct amount of heat to apply.

2.1.2 Temperature sensitive paint shall exist on the outer surface of the sleeve as an indicator at the time of installation only, whilst two white lines shall appear on top of the sleeve to serve as permanent indicators that a correct amount of heat has been applied.

2.1.3 Hot melt adhesive shall exist which will seal the closure seam and bond the sleeve to the liner and the closure outlets to the cable sheaths during installation.

2.1.4 A preformed laminated liner shall be provided with the closure which shall be fitted prior to installing the closure. This liner shall assist in providing mechanical protection, maintaining the joint uniform and also act as a heat barrier during installation. It shall provide adequate structural strength to preclude collapse during installation.

2.1.5 The closure channel shall be manufactured from stainless steel in accordance with X5 CR NI 189 (DIN 17440) or AISI 304.

2.1.6 The uninstalled system shall be capable of being stored at temperatures between -30°C and +60°C without deterioration of the product performance.

2.1.7 The closure shall be installable at temperatures between -10°C and +45°C.

2.1.8 The kits shall contain all the necessary components for a complete installation with the exception of the filling compound which may be provided

separately. Each kit shall be supplied with a detailed installation instruction pertaining to signal cable.

2.1.9 Each kit shall have a label with the following information:

- Supplier's Name
- Product Description
- Batch Number
- Customer Item Code Number as requested by RCA

2.1.10 The closure technology, in the form of a similar or identical product, shall be approved by the Australian Communications Authority (ACA). This will demonstrate that the product has been fully tested to local conditions.

2.1.11 The closure shall have a minimum dielectric strength of 120 KV/cm.

2.1.12 The closure shall comply with the tests as detailed in Appendix A.

## **2.2. RSS Joint Filling Compound and RSSK Kit**

2.2.1 The Closure system shall be supplied with a filling compound which shall be placed around the crimp sleeves prior to installing the zip sleeve. This compound shall be Raychem RSS filling compound or direct technical equivalent.

2.2.2 The filing compound shall be one approved by Australian Communications Authority (ACA). This will demonstrate that the product has been fully tested to local conditions.

2.2.3 In addition to the RSS filling compound, a kit containing mastic and plastic sheets will be required to hold the filling compound. This kit shall be the Raychem RSSK kit or direct technical equivalent.

## **2.3. Heatshrink Jointing and Repair Sleeves**

This heatshrink material will be used for the jointing of power cable and screened track cable and for the jacket or outer sheath repair of power cable and multicore signal cable.

2.3.1 The heatshrink shall be installable at temperatures between -10°C and +45°C.

2.3.2 Printed at no more than 200mm intervals on the heatshrink shall be product name and supplied and recovered size.

2.3.3 Adhesive shall be hot melt and not mastic type.

2.3.4 The heatshrink shall have a minimum dielectric strength of 140 KV/cm.

## **3. Jointing of Power Cable – Single Conductors**

Installation instructions are detailed in Appendix D. Refer also to Drawing No. M08-804.

Following the jointing of conductor by approved procedure, i.e. standard crimp sleeve and crimping tool, as described in Section 7, the joint will be protected by heatshrink.

The heatshrink sleeve shall be Raychem WCSM heavy wall heatshrink or direct

technical equivalent and shall meet the criteria as detailed in 2.3.

Heatshrink size and length shall be as detailed in table on Drawing No. M08-804.

#### **4. Jointing of Power Cable – Twin Core Shielded**

Installation instructions are detailed in Appendix E. Refer also to Drawing No.M08-805.

Following the jointing of the conductors by approved procedure, i.e. standard crimp sleeves and crimping tool, as described in Section 7, each sleeve shall be protected by heatshrink.

The heatshrink sleeve shall be Raychem WCSM heavy wall heatshrink or direct technical equivalent and shall meet the criteria as detailed in 2.3.

Heatshrink size and length shall be as detailed in table on Drawing No.M08-805.

The closure shall then be completed by installing an XAGA 530 43/8-250 zip sleeve incorporating Raychem RSS filling compound or direct technical equivalents. The closure shall comply with requirements as detailed in Section 2.1 and Appendix A.

#### **5. Jacket or Outer Sheath Repair of PVC Signal and Power Cable**

Installation instructions are detailed in Appendix C. Refer also to Drawing No.M08-807.

The approved method of repair shall be heatshrink wraparound sleeve.

Raychem CRSM wraparound sleeve or direct technical equivalent shall be used on cable with an outside diameter of greater than 12mm and shall meet the criteria as detailed in 2.3.

Heatshrink size shall be as detailed on Drawing No.M08-807.

Cable with an outside diameter of less than 12mm will require cutting with the damaged section removed and the cable rejoined.

#### **6. Jointing of Screened High Frequency Track Cable**

Installation instructions are detailed in Appendix F. Refer also to Drawing No.M08-806.

The conductors and screen drain wire shall be joined by approved procedure, i.e. standard crimp sleeves and crimping tools as described in Section 7.

The first part of the closure shall be an adhesive lined heatshrink sleeve, Raychem TWST 17/4-150 or direct technical equivalent. This sleeve shall act as a moisture block.

The sleeve shall be installable at temperatures between -10°C and +45°C. Adhesive shall be hot melt and not mastic type.

The heatshrink shall have a minimum dielectric strength of 200 KV/cm.

Additional mechanical protection shall be provided by installing a heatshrink sleeve over this inner sleeve.

The outer heatshrink sleeve shall be Raychem WCSM 19/6 heavy wall heatshrink cut to 240mm length or direct technical equivalent and shall meet the criteria as detailed in 2.3.



## 7. Crimp Sleeves and Crimping Tools

### 7.1. General

PVC Signal and mains cables shall be jointed using the cold welding process of individual conductors with crimp type sleeves. All concerned should be aware that the use of the correct sleeve and crimping tool is essential in maintaining the integrity of the crimp sleeve over a long period. The fact that a test crimp cannot be pulled apart is no guarantee that the joint is satisfactory. The manufacturer's recommendations must be followed, and further, the use of worn tools must be avoided as any pivot wear substantially reduces the crimping force.

At the present time, Utilux sleeves, crimps and tools are in general use and Standard Specification 707 lists the most common crimp lugs and cable crimp tool details giving the correct tools, sleeves and crimps required for each cable size.

### 7.2. Signal Cable and High Frequency Screened Track Cable

Crimp sleeves shall be Utilux H2071 or Utilux H3910 or equivalent crimped with Utilux tool 11C or equivalent.

**NOTE:** H2071 is not a "Supergrip" sleeve. "Supergrip" sleeves will no longer be essential in cable jointing.

### 7.3. Power Cable

The following table shall be followed when choosing which crimp link or crimping tool to use:

Conductor Size	(mm <sup>2</sup> )	Utilux Catalogue Number	Crimping Tool	Crimping Die
7/0.50	(1.5)	H2071	11C	-
		H3910	11C	-
7/0.85	(4)	(Supergrip) H2073	13B	-
		H3912	13B	-
7/1.70	(16)	(Supergrip) H1455	38A	38-63CU
19/1.35	(25)	H1458	38A	38-77CU
19/1.53	(35)	H1488	38A	38-92CU
19/1.78	(50)	H1460	38A	38-104CU
19/2.14	(70)	H1461		38-115CU
37/1.78	(95)	H1462		38-142CU
37/2.03	(120)	H1492		38-165CU

The use of any other type of crimp link or crimping tool will require type approval.

## 8. Appendix A: Signal Cable Closure System – Acceptance Test Requirements

- A1) The closure shall exhibit a very high degree of split resistance and shall comply with the following test::

A 5mm cut shall be made on one edge of the sleeve prior to installation over the maximum application diameter of the sleeve.

The sleeve can be installed with a torch or in an oven at 200°C for 15 minutes.

There shall be no significant propagation of the cut, as determined by examination with the naked eye.

- A2) The tightness of installed closures shall be checked by pressurizing to 40kpa for a period of 15 minutes while immersed in water at room temperature.

A sample shall be considered tight if there is no continuous stream of air bubbles escaping from it.

- A3) The closure shall be capable of withstanding installation using strong torches.

After installing the sleeve according to standard procedures use an approved torch with a gas pressure of 150kpa and allow the yellow tip to impinge the surface for 10 seconds.

The sleeve shall then pass examination with the naked eye and be subjected to the tightness test as described in A2.

- A4) Longitudinal shrinkage of the closure shall be less than 5% so as to ensure a consistent bond length and enhance reliability.

The length of the shortest sleeve sample as delivered shall be determined to the nearest millimeter, (mean of 4 measurements taken across sleeve). The sleeve shall then be shrunk onto an aluminum tube with an outside diameter equivalent to the maximum applicable diameter tube shall not exceed 3mm and its outside surface shall be treated with a release agent. The minimum length of the sleeve shall be determined after the sample has cooled to room temperature.

The percentage longitudinal shrinkage shall be calculated as follows:

$$\frac{\text{mean length shrunk} - \text{mean length as delivered}}{\text{mean length as delivered}} \times 100$$

- A5) Closures shall have to withstand two types of mechanical testing (i.e. impact test and blunt blade test). For the duration of these tests the closures shall be internally pressurized to 40kpa.

The impact test shall consist of the closure being placed on a smooth, flat,

horizontal surface with the seam rotated 90° from the point of impact.

A steel ball weighing 1kg shall be suspended at a height of 2m above the centre of the test specimen. The weight shall be allowed to fall under gravity, striking the test specimen at the apex of the curvature.

After inspection with the naked eye, the closure shall be subjected to the tightness test as described in A2.

The blunt blade test shall be performed by placing the closure on a 5cm layer of dry sand. A blunt steel blade of 6kg with a shape as indicated on Drawing No. M08-808 shall be allowed to fall under gravity from a height of 30cm at less than 0°C and from a height of 90cm at temperatures above 0°C. The closure shall be positioned such that the impacts do not occur on the channel or clip.

After inspection with the naked eye, the closure shall be subjected to the tightness test as described in A2.

## 9. Appendix B: PVC Signal Cable Closure, Installation Procedure

CABLE RANGE	KIT SIZE
4 Core to 15 Core	XAGA 530 43/8-300 SRA1 or direct technical equivalent
16 Core to 63 Core	XAGA 530 75/15-400 SRA2 or direct technical equivalent

- B1) Ensure all materials are available before commencing. Materials will be supplied in the kit, with the exception of the RSS grease, RSSK Mastic kit and cartridge gun. Crimp sleeves will also not be supplied.
- B2) Prepare cable as per dimension drawing M08-803 for XAGA 75/15 or M08-802 for XAGA 43/8, join conductors using approved crimp sleeves and crimping tool as described in Section 7.
- B3) Generally speaking, conductor joints in multicore cables must be staggered. However, it is permissible to have 2 to 4 joints, depending on the diameter of the cable, not staggered but arranged fairly equally around the periphery of the cable. Joints lying together in adjacent layers should be avoided as far as possible.
- B4) The internal copper tapes of the cable must be electrically connected across the joint. This connection must be made by sweating 7/0.85mm cable to the copper screens on either side of the joint.
- B5) Thoroughly clean the copper screen and inner PVC sheath with approved cleaning tissue Raychem EPPA001 or direct technical equivalent.
- B6) Open the RSSK kit and wrap the mastic strip around the cable to determine the length for one wrap. Cut one piece for each cable end and apply over the outer PVC sheath.
- B7) Select mylar film and fold if necessary to adjust width. The mylar film with incorporated grease fill must cover the copper tape and solder connections. Stick the corners of the film to the centre of the mastic strips. Wrap the film partially around the splice, leaving the top open. Firmly press the edges of the film on to the mastic.
- B8) Using a cartridge gun, inject RSS grease into the splice. Typically using two thirds of a cartridge on a 50 Core joint. It is better to use more grease than not enough.
- B9) Stretch the mylar film and tightly wrap it around the encapsulated splice. Wrap entire film around.
- B10) Seal both ends of the mylar film with a number of layers of PVC tape, applied under tension to provide an adequate seal. The tape should also overlap onto the cable jacket by 10mm.
- B11) Squeeze the splice, beginning in the centre to force the grease thoroughly into the splice bundle. Continue squeezing until the grease has been forced into all voids and both ends.
- B12) Wrap the splice completely with PVC tape using 50% overlap, but do not stretch the first layer of tape. Stretch and tightly wrap two additional layers of

tape onto the splice, again using 50% overlap.

- B13) Wrap the white inner preformed liner around the splice bundle and secure in the middle with PVC tape. Tape the crowns, starting from the liner body down to the cable with a 50% overlap. Tape a maximum of 5mm onto the cable.
- B14) Clean outer PVC sheath with approved cleaning tissue Raychem EPPA001 or direct technical equivalent, provided for a distance of 150mm either side of the liner. Do not touch and contaminate cleaned area.
- B15) Abrade this cleaned section with emery cloth provided. Abrade circumferentially, not lengthwise. **DO NOT** preheat or flame brush the cable as this could prevent the sleeve bonding satisfactorily to the cable.
- B16) Wrap the heatshrinkable sleeve around the splice. Press the underclip over the rail at the centre of the sleeve. Pull flexible channels over the sleeve rails until they butt on top of the underclip.
- B17) A maximum of 5mm nylon jacket may extend into sleeve on both ends, heatshrink will not satisfactorily adhere to nylon.
- B18) The correct type and size of flame is essential in the satisfactory application of heatshrink.
- B19) Liquid Petroleum Gas (LPG) shall be used and the following two torches have been approved. **DO NOT USE ACETYLENE, HOT AIR GUN OR PLUMBING NOZZLES.**
  - a) **Raychem:** FH1630-HS handle, FH1630-BN25 Nozzle, FH1630-HA6 hose adapter (if local hose used) or FH1630-S5 hose (HA6 hose adapter is not required). Regulator must be purchased separately.
  - b) **Bulgin:** ADL65 heatshrink gun, NGA64 Auto frame, AP106/65 Multi-burner, LPG W/F-3 Hose and three different regulators depending on brand of cylinder, PR102A(POL), PR1025(Companion) or PR1020 Primus.
- B20) Adjust torch to obtain a soft blue flame with yellow tip and start shrinking at the centre of the sleeve and heat circumferentially until the thermo-indicating paint has changed colour from green to black. Keep the flames moving continuously to avoid scorching the material.
- B21) When the temperature sensitive paint has completely changed to black, gradually and progressively move towards the end, turning the flame around the closure.
- B22) White lines should appear at the top of the channel area as a permanent indicator that sufficient heat and shrinkage of sleeve has been attained.
- B23) Support the splice under the shoulder and press the channel with a blunt tool to follow the form of the splice shoulder.
- B24) Repeat these steps for the other end of closure.
- B25) **DO NOT** attempt to move or bury closure until completely cooled, typically 10 to 30 minutes.

## 10. Appendix C: Jacket or Outer Sheath Repair of PVC Signal and Power Cable, Installation Procedure

**NOTE:** Zip type wraparound heatshrink should not be used on cables with an outside diameter of less than 12mm. These cables will require cutting, with the damaged section removed and the cable rejoined.

- C1) Referring to Drawing No. M08-807, measure outside diameter of cable and select correct size wraparound sleeve from Table.
- C2) Cut zip wraparound sleeve to length. Ensure the wraparound extends at least 50mm at each end beyond the area to be protected.
- C3) Remove nylon jacket on area to be covered by sleeve. A maximum of 5mm nylon jacket may extend into sleeve on both ends, heatshrink will not satisfactorily adhere to nylon.
- C4) Thoroughly clean area of cable which will come into contact with heatshrink with approved cleaning tissue, Raychem EPPA001 or direct technical equivalent. **DO NOT** touch and contaminate cleaned area.
- C5) Abrade this cleaned section with emery cloth, P80 grit size. Abrade circumferentially, not length-wise. **DO NOT** preheat or flame brush the cable as this could prevent the sleeve bonding satisfactorily to the cable.
- C6) Position the wraparound centrally. Slide the steel channel onto the rails.
- C7) The correct type and size of flame is essential in the satisfactory application of heatshrink.
- C8) Liquid Petroleum Gas (LPG) shall be used and the following two torches have been approved. **DO NOT USE ACETYLENE, HOT AIR GUN OR PLUMBING NOZZLES.**
  - a) **Raychem:** FH1630-HS handle, FH1630-BN25 Nozzle, FH1630-HA6 hose adapter (if local hose used) or FH1630-S5 hose (HA6 hose adapter is not required). Regulator must be purchased separately.
  - b) **Bulgin:** ADL65 heatshrink gun, NGA64 Auto frame, AP106/65 Multi-burner, LPG W/F-3 Hose and three different regulators depending on brand of cylinder, PR102A (POL), PR1025 (Companion) or PR1020 Primus.
- C9) Adjust torch to obtain a soft blue flame with a yellow tip and start shrinking at the centre of the sleeve opposite the channel working around towards the channel and towards the ends. Continue heating until adhesive flows out of both ends. Then briefly heat the channel area.
- C10) **DO NOT** attempt to move or bury cable until completely cooled, typically 10 to 30 minutes.

**Table:**

<b>Wraparound Heat Shrink Sleeve</b>	<b>Application Range (Outside diameter)</b>
Raychem CRSM 34/10 or direct technical equivalent	12 mm - 21 mm
Raychem CRSM 50/15 or direct technical equivalent	17 mm - 30 mm
Raychem CRSM 75/22 or direct technical equivalent	25 mm - 40 mm
Raychem CRSM 100/30 or direct technical equivalent	35 mm - 55 mm

## 11. Appendix D: PVC Power Cable Jointing – Single Conductors, Installation Procedure

- D1) Prepare cable as per dimension Drawing No. M08-804. Select correct size Heatshrink, crimp sleeve and crimping tool by referring to Table on Drawing. Heatshrink shall be Raychem WCSM heavy wall heatshrink or direct technical equivalent.
- D2) Join core, using correct size crimp sleeve and crimping tools as described in Section 7.
- D3) Thoroughly clean area of cable which will come into contact with Heatshrink with approved cleaning tissue, Raychem EPPA001 or direct technical equivalent. **DO NOT** touch and contaminate cleaned area.
- D4) Abrade this cleaned section with emery cloth, P80 grit size. Abrade circumferentially, not length-wise. **DO NOT** preheat or flame brush the cable as this could prevent the sleeve bonding satisfactorily to the cable.
- D5) Centre the Heatshrink sleeve over the crimp sleeve. A maximum of 5mm nylon jacket may extend into sleeve on both ends, heatshrink will not satisfactorily adhere to nylon.
- D6) The correct type and size of flame is essential in the satisfactory application of heatshrink.
- D7) Liquid Petroleum Gas (LPG) shall be used and the following two torches have been approved. **DO NOT USE ACETYLENE, HOT AIR GUN OR PLUMBING NOZZLES.**
  - a) **Raychem:** FH1630-HS handle, FH1630-BN25 Nozzle, FH1630-HA6 hose adapter (if local hose used) or FH1630-S5 hose (HA6 hose adapter is not required). Regulator must be purchased separately.
  - b) **Bulgin:** ADL65 heatshrink gun, NGA64 Auto frame, AP106/65 Multi-burner, LPG W/F-3 Hose and three different regulators depending on brand of cylinder, PR102A (POL), PR1025 (Companion) or PR1020 Primus.
- D8) Adjust torch to obtain a soft blue flame with a yellow tip and start shrinking at the centre of the sleeve working toward the ends. Continue heating until adhesive flows out of both ends.
- D9) **DO NOT** attempt to move or bury closure until completely cooled, typically 10 to 30 minutes.



## 12. Appendix E: PVC Power Cable Jointing – Twin Core Shielded, Installation Procedure

- E1) Prepare cable as per dimension Drawing No. M08-805. Select correct size inner heatshrink, crimp sleeve and crimping tool by referring to Table on Drawing.

### Core Preparation

- E2) Join cores using correct size crimp sleeve and crimping tool, as described in Section 7. **Stagger sleeves:** Each sleeve is to be covered with Raychem WCSM heavy wall heatshrink or direct technical equivalent.

**NOTE: 7/0.85mm cable does not require heatshrink as pre-insulated sleeves are utilized.**

- E3) Thoroughly clean area of cable which will come into contact with Heatshrink with approved cleaning tissue, Raychem EPPA001 or direct technical equivalent. **DO NOT** touch and contaminate cleaned area.
- E4) Abrade this cleaned section with emery cloth, P80 grit size. Abrade circumferentially, not length-wise. **DO NOT** preheat or flame brush the cable as this could prevent the sleeve bonding satisfactorily to the cable.
- E5) Centre Heatshrink sleeve over crimp sleeve.
- E6) The correct type and size of flame is essential in the satisfactory application of heatshrink.
- E7) Liquid Petroleum Gas (LPG) shall be used and the following two torches have been approved. **DO NOT USE ACETYLENE, HOT AIR GUN OR PLUMBING NOZZLES.**
- a) **Raychem:** FH1630-HS handle, FH1630-BN25 Nozzle, FH1630-HA6 hose adapter (if local hose used) or FH1630-S5 hose (HA6 hose adapter is not required). Regulator must be purchased separately.
  - b) **Bulgin:** ADL65 heatshrink gun, NGA64 Auto frame, AP106/65 Multi-burner, LPG W/F-3 Hose and three different regulators depending on brand of cylinder, PR102A (POL), PR1025 (Companion) or PR1020 Primus.

- E8) Adjust torch to obtain a soft blue flame with a yellow tip and start shrinking at the centre of the sleeve working toward the ends. Continue heating until adhesive flows out of both ends.

### Sheath Preparation

- E9) The internal copper tapes of the cable must be electrically connected across the joint. This connection must be made by sweating 7/0.85mm cable to the copper screens on either side of the joint.
- E10) Thoroughly clean the copper screen and inner PVC sheath with approved cleaning tissue Raychem EPPA001 or direct technical equivalent.
- E11) Open the RSSK kit and wrap the mastic strip around the cable to determine

the length for one wrap. Cut one piece for each cable end and apply over the outer PVC sheath. The plastic sheet with incorporated grease fill must cover the copper tape and solder connections.

- E12) Select mylar film and fold if necessary to adjust width. The mylar film with incorporated grease fill must cover the copper tape and solder connections. Stick the corners of the film to the centre of the mastic strips. Wrap the film partially around the splice, leaving the top open. Firmly press the edges of the film on to the mastic.
- E13) Using a cartridge gun, inject RSS grease into the splice. Typically using two thirds of a cartridge on a 50 Core joint. It is better to use more grease than not enough.
- E14) Stretch the mylar film and tightly wrap it around the encapsulated splice. Wrap entire film around.
- E15) Seal both ends of the mylar film with a number of layers of PVC tape, applied under tension to provide an adequate seal. The tape should also overlap onto the cable jacket by 10mm.
- E16) Squeeze the splice, beginning in the centre to force the grease thoroughly into the splice bundle. Continue squeezing until the grease has been forced into all voids and both ends.
- E17) Wrap the splice completely with PVC tape using 50% overlap, but do not stretch the first layer of tape. Stretch and tightly wrap two additional layers of tape onto the splice, again using 50% overlap.
- E18) Wrap the white inner liner around the splice bundle and secure in the middle with PVC tape. Tape the crowns, starting from the liner body down to the cable with a 50% overlap. Tape a maximum of 5mm onto the cable.
- E19) Clean outer PVC sheath with approved cleaning tissue Raychem EPPA001 or direct technical equivalent, provided for a distance of 150mm either side of the liner. **DO NOT** touch and contaminate cleaned area.
- E20) Abrade this cleaned section with emery cloth provided. Abrade circumferentially, not length-wise. **DO NOT** preheat or flame brush the cable as this could prevent the sleeve bonding satisfactorily to the cable.
- E21) Wrap the heatshrinkable sleeve around the splice. Press the underclip over the rail at the centre of the sleeve. Pull flexible channels over the sleeve rails until they butt on top of the underclip.
- E22) A maximum of 5mm nylon jacket may extend into sleeve on both ends, heatshrink will not satisfactorily adhere to nylon.
- E23) Adjust torch to obtain a soft blue flame with yellow tip and start shrinking at the centre of the sleeve and heat circumferentially until the thermo-indicating paint has changed colour from green to black. Keep the flame moving continuously to avoid scorching the material.
- E24) When the temperature sensitive paint has completely changed to black, gradually and progressively move towards the end, turning the flame around the closure.

- E25) White lines should appear at the top of the channel area as a permanent indicator that sufficient heat and shrinkage of sleeve has been attained.
- E26) Support the splice under the shoulder and press the channel with a blunt tool to follow the form of the splice shoulder.
- E27) Repeat these steps for the other end of closure.
- E28) **DO NOT** attempt to move or bury closure until completely cooled, typically 10 to 30 minutes.

### 13. Appendix F: Screened High Frequency Track Cable – Installation Procedure

- F1) Prepare cable as per dimension Drawing No. M08-806, join conductors and shield drain wire using approved crimp sleeves and crimping tool as described in Section 7.
- F2) Stagger crimp sleeves as shown on Drawing.
- F3) Thoroughly clean area of cable which will come into contact with Heatshrink with approved cleaning tissue, Raychem EPPA001 or direct technical equivalent. **DO NOT** touch and contaminate cleaned area.
- F4) Centre inner heatshrink sleeve Raychem TWST 17/4-150, or direct technical equivalent over crimp sleeves.
- F5) The correct type and size of flame is essential in the satisfactory application of heatshrink.
- F6) Liquid Petroleum Gas (LPG) shall be used and the following two torches have been approved. **DO NOT USE ACETYLENE, HOT AIR GUN OR PLUMBING NOZZLES.**
  - a) **Raychem:** FH1630-HS handle, FH1630-BN25 Nozzle, FH1630-HA6 hose adapter (if local hose used) or FH1630-S5 hose (HA6 hose adapter is not required). Regulator must be purchased separately.
  - b) **Bulgin:** ADL65 heatshrink gun, NGA64 Auto frame, AP106/65 Multi-burner, LPG W/F-3 Hose and three different regulators depending on brand of cylinder, PR102A (POL), PR1025 (Companion) or PR1020 Primus.
- F7) Adjust torch to obtain a soft blue flame with a yellow tip and start shrinking at the centre of the sleeve working toward the ends. Continue heating until adhesive flows out of both ends.
- F8) Prepare cable for outer heatshrink sleeve by thoroughly cleaning area of cable which will come in contact with heatshrink with approved cleaning tissue, Raychem EPPA001 or direct technical equivalent. **DO NOT** touch and contaminate cleaned area.
- F9) Abrade this cleaned section with emery cloth, P80 grit size. Abrade circumferentially, not length-wise. **DO NOT** preheat or flame brush the cable as this could prevent the sleeve bonding satisfactorily to the cable.
- F10) Outer heatshrink sleeve shall be Raychem WCSM 19/6 heavy wall heatshrink cut to 240mm lengths or direct technical equivalent.
- F11) Centre the outer heatshrink sleeve over the inner heatshrink sleeve. A maximum of 5mm nylon jacket proofing may extend into sleeve on both ends. Heatshrink will not satisfactorily adhere to nylon.
- F12) Adjust torch to obtain a soft blue flame with a yellow tip and start shrinking at the centre of the sleeve working toward the ends. Continue heating until adhesive flows out of both ends.

- F13) **DO NOT** attempt to move or bury closure until completely cooled, typically 10 to 30 minutes.