# Engineering Standard

SAES-T-632 7 May 2019

Telecommunications: Splicing Copper Cables,
Fiber Optic Cables and Types of Splice Closure

Document Responsibility: Communications Standards Committee

**Contents**






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## 1 Scope

This standard describes the minimum requirements and the acceptable methods of splicing communications cables and types of splice cases/closures for copper (plastic insulated) and fiber optics cables.

Typical applications of these methods is for outside plant (OSP) which include buried, underground splices and aerial application for OSP is not recommended, and it is use only for temporary applications. Also, this apply for inside plant (ISP) installation with an approved types for indoor application.

## 2 Conflicts and Deviations

Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAES's), Materials System Specifications (SAMSS's), Standard Drawings (SASD's), or industry standards, codes, and forms shall be resolved in writing by the Responsible Department Manager (RDM) for this standard in accordance with internal company procedure SAEP-302.

## 3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

### 3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

| | |
|---|---|
| *SAEP-302* | *Waiver of a Mandatory Saudi Aramco Engineering Requirement* |

Saudi Aramco Engineering Standards

| | |
|---|---|
| *SAES-T-018* | *Telecommunications - Symbols, Abbreviations, and Definitions* |
| *SAES-T-624* | *Telecommunications Outside Plant - Fiber Optics* |
| *SAES-T-634* | *Telecommunications - Cable Testing and Acceptance* |
| *SAES-T-795* | *Grounding Systems for Communications Facilities* |
| *SAES-T-903* | *Telecommunications Outside Plant Electrical Protection and Grounding* |
| *SAES-T-920* | *Telecommunications Cable Information* |


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Saudi Aramco Materials System Specification

| | |
|---|---|
| *18-SAMSS-625* | *Outside Plant - Fiber Optic Cable Specifications (Single Mode and Multiple Mode)* |

Saudi Aramco General Instruction

| | |
|---|---|
| *GI-1021.000* | *Street and Road Closure: Excavations, Reinstatement, and Traffic Controls* |

3.2 Industry Codes and Standards

Building Industry Consulting Services International

| | |
|---|---|
| *BICSI (TDMM)* | *Telecommunications Distribution Methods Manual (Latest Version)* |
| *BICSI (OSPDM)* | *Outside Plant Design Reference Manual (Latest Version)* |

National Fire Protection Association

| | |
|---|---|
| *NFPA 70* | *National Electrical Code (NEC)* |

Rural Utilities Service (RUS)

| | |
|---|---|
| *BULLETIN 1753F-401* | *RUS Standard for Splicing Copper and Fiber Optic Cables* |

## 4 Definition

**Acceptance Test:** A test or set of tests performed to demonstrate satisfactory completion of a predetermined task or group of tasks on which project acceptance is dependent.

**Bridged Tap:** A connection that enables multiple appearances of the same cable pair at several distribution points.

**Buried Cable:** A cable that is installed under the surface of the ground in such a manner that it cannot be removed without disturbance to the soil. Also referred to as direct-buried cable.

**Butt Splice:** A splice case or closure where cables to be spliced enter from one end only.

**Cable Vault:** A telecommunications space, typically subterranean, located within or between buildings and used for the distribution, splicing, and termination of cabling.

**Encapsulant:** A permanent or removable filling compound for a splice enclosure to prevent water intrusion.


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**Even Count:** Copper cable with each 25 pair count starting with 1, 26, 51, 76, 101, etc. All PIC cable is of even-count construction.

**Odd Count:** Copper cable with additional spare pairs in the pair count. 25 pair groups count may not start pair # 26, 51, etc.

**Splicing:** The permanent joining of fiber ends to identical or similar fibers without the use of a connector.

**Splice Case or Splice Closure:** A metal or plastic housing with a semi-cylindrical cavity used in identical pairs to clamp around a cable splice to provide a closure.

**Straight Splice:** A splice case or closure where one cable enters from one end and the other cable enters from the other end.

**Underground Cable:** A telecommunications cable installed under the surface of the earth in a trough or duct that isolates the cable from direct contact with the soil.

# 5 Design

## 5.1 General

### 5.1.1 Splicing

5.1.1.1 Splicing Hardware

Commonly known as splices cases or other words splice closures, is used in outside plant (OSP) and inside plant (ISP) to enclose splices.

5.1.1.2 Splicing Locations

Splicing hardware can be constructed of metallic or nonmetallic materials and can be found in underground, direct-buried, and aerial (as per Saudi Aramco standard aerial is for temporary use) construction such as: Pedestal, Handhole (HH), Maintenance hole (MH), Ploes, Support strand, Buildings, Vaults and Splice pits (buried splice).

5.1.1.3 Both cables copper and fiber optic strands shall be free from defects. It is desirable that installed cable sections be tested before splicing.

- Each reel of cable for copper cables are recommended to be tested for grounds, opens, shorts, crosses, and shield continuity before and after installation.


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- Also, it is recommended for FOC to be tested by OTDR (Optical Time – Domain Reflectometer) for continuity and dB loss before and after installation.

*Commentary Note:*

*Before splicing, the cables shall be tested, recorded before and after installation.*

5.1.1.4 Cables and splicing materials used on outside plant projects shall be of filled type. Copper cables shall comply with SAES-T-920, fiber optic cables shall comply with 18-SAMSS-625.

5.1.1.5 The design engineer should carefully consider the amount and location of the splice closures in underground cable plant, whether the transmission medium is copper or optical fiber cable. The goal is to maximize cable run and minimize splices, since they may be a source of unpredictable amount of subsequent troubles.

5.1.1.6 Fusion splices

Electric arc-fusion is the most widely used method to make reliable single or mass optical splices in the field. The fusion process is realized by using specially-developed splicing machines.

### 5.1.2 Cases/Closures

5.1.2.1 Lead sheath splice closures shall not be used, since lead sheath cable is no longer used by Saudi Aramco for new Construction.

5.1.2.2 Thermo fit (heat shrinkable) wrap around sleeves are available for cable sheath repairs and as splice closures on new cable Construction.

5.1.2.3 When placing or handling encapsulating compounds, observe manufacturer's warnings and safety precautions, warnings and all other applicable Saudi Aramco safety standards and instructions.

5.1.2.4 All direct buried or underground cable splice closures shall be filled with a re-enterable encapsulating compound.

5.1.2.5 Due to the requirement for heat for the installation of the heat-shrinkable (thermo fit) sleeves (closures), discernment must be used in selecting locations in which it will be used and all


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applicable safety precautions and Loss Prevention standards adhered to. Installations are to be made in accordance with manufacturer's instructions.

### 5.1.3 Others (Safety and etc.)

5.1.3.1 For personnel safety, the shields and metallic strength members of the cables to be spliced shall be bonded together and grounded before splicing activities are started.

5.1.3.2 Only non-filled fire retardant rated splices shall be used only in buildings to splice an outside plant cables with an indoor cables. OSP cables within the building shall be wrapped with fireproof tape. Indoor cables shall be listed as Communication Riser Cable (Type CMR) in accordance with NFPA 70 "National Electrical Code".

*Commentary Note:*

*Splices shall be made as close as practical to the point where the outside plant cables enter the building within 15 meters.*

5.1.3.3 Special care shall be exercised to avoid damaging the conductor insulation when cutting through the cable shield and removing the shield. Sharp edges and burrs shall be removed from the cut end of the shield.

5.1.3.4 Fiber Optic Splicing Safety

(1) Safety glasses shall be worn when handling glass fibers.

(2) Never view open-ended fibers with the naked eye or a magnifying device. Improper viewing of a fiber end that is transmitting light may cause irreparable eye damage.

(3) Dispose of bare scrap fibers by using the sticky side of a piece of tape to pick up and discard loose fiber ends. Fiber scraps easily penetrate the skin and are difficult to remove.

(4) During the splicing operations, handle fibers carefully to avoid introducing flaws, breaking or scratching the fiber surface or in any way damaging the fibers (sharp bends, crushing forces, etc.)

5.1.3.4 Bonding and Grounding

(1) Bonding and grounding of cables and splice cases shall be


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in accordance with SAES-T-795.

(2) Bonding clips shall be provided on all metallic cable to permit reliable electrical connections to the aluminum shield for noise-shielding purposes and for maintenance of electrical continuity.

(3) Prior to starting splice work, as a safety precaution, place a temporary bonding jumper across the splice opening to join all metallic members of any cables that are not all dielectric, and bond them to the local ground electrode.

## 5.2 Splicing Consideration

### 5.2.1 Fiber Optics Cable (FOC) Consideration

This section specifies the minimum splicing requirements for fiber optic cables (FOC).

5.2.1.1 The following sections shall comply the requirements stated on this standards:

- BULLETIN 1753F-401, RUS Standard for Splicing Copper and Fiber Optic Cable

  As follows;

  (1) Buffer Tube Removal
  (2) Coated Fiber Cleaning
  (3) Fiber Coating Removal
  (4) Bare Fiber Cleaning
  (5) Fiber Cleaving
  (6) Cleaved Fiber Handling
  (7) Underground Manhole Splices
  (8) Splice Arrangement for Fiber Optic cables

  The following requirement shall be added:

  ➢ Buried Splices

  It shall be installed in handholes or splice vaults (known as Optiped) to accommodate the splice case and the required splicing slack. An alternative to the Optiped is a cabinet or pedestal specifically designated for fiber optic splice cases.


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*Commentary Notes:*

*Typical locations that may utilize fiber splice pedestals are classified areas inside plants where maintenance holes and hand holes are not permitted.*

*The use of direct buried splice closure installation method shall be submitted to the committee chairman for approval.*

- BICSI OSPDM: Outside Plant Design Reference Manual (Latest Version)
- BICSI (TDMM): Telecommunications Distribution Methods Manual (Latest Version)

Below are added minimum requirements that shall be meet adhere to splicing fiber optics cables;

*Commentary Note:*

*Only fusion splicing technique is permitted. However, if for some reason, mechanical splicing technique is chosen, a justifying waiver must be issued for approval before any splice work is commenced.*

5.2.1.2 Outside Plant (OSP) fiber optic cables shall comply with 18-SAMSS-625.

5.2.1.3 Connection characteristics: Splicing efficiency between optical fibers is a function of light loss across the fiber junctions measured in decibels (dB). Only same type fibers shall be spliced together. Non-identical fibers shall not be spliced.

*Commentary Note:*

*Splice loss shall not be more than 0.2 dB per splice, a loss of 0.2 dB in a splice corresponds to a light transmission efficiency of approximately 95.5%.*

5.2.1.4 Fiber core alignment: Fiber splicing techniques shall be conducted in such a manner that the cores of the fibers will be aligned as perfectly as possible to allow maximum light transmission from one fiber to the next. Core misalignment is illustrated in Figure 1:


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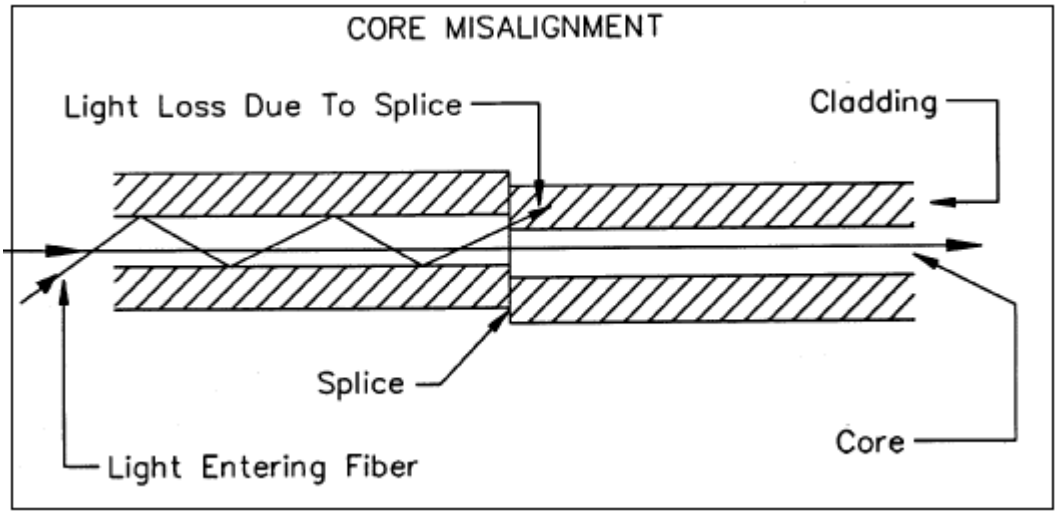


**Figure 1 - Core Misalignment**

5.2.1.5 Splice Loss

Splice loss can also be caused by fiber defects such as non-identical core diameters, cores not in center of the fiber, and noncircular cores. Such defects are depicted in Figure 2:

*Commentary Note:*

*Undesirable splice losses are caused by poor splicing techniques including splicing irregularities such as improper cleaves and dirty splices.*


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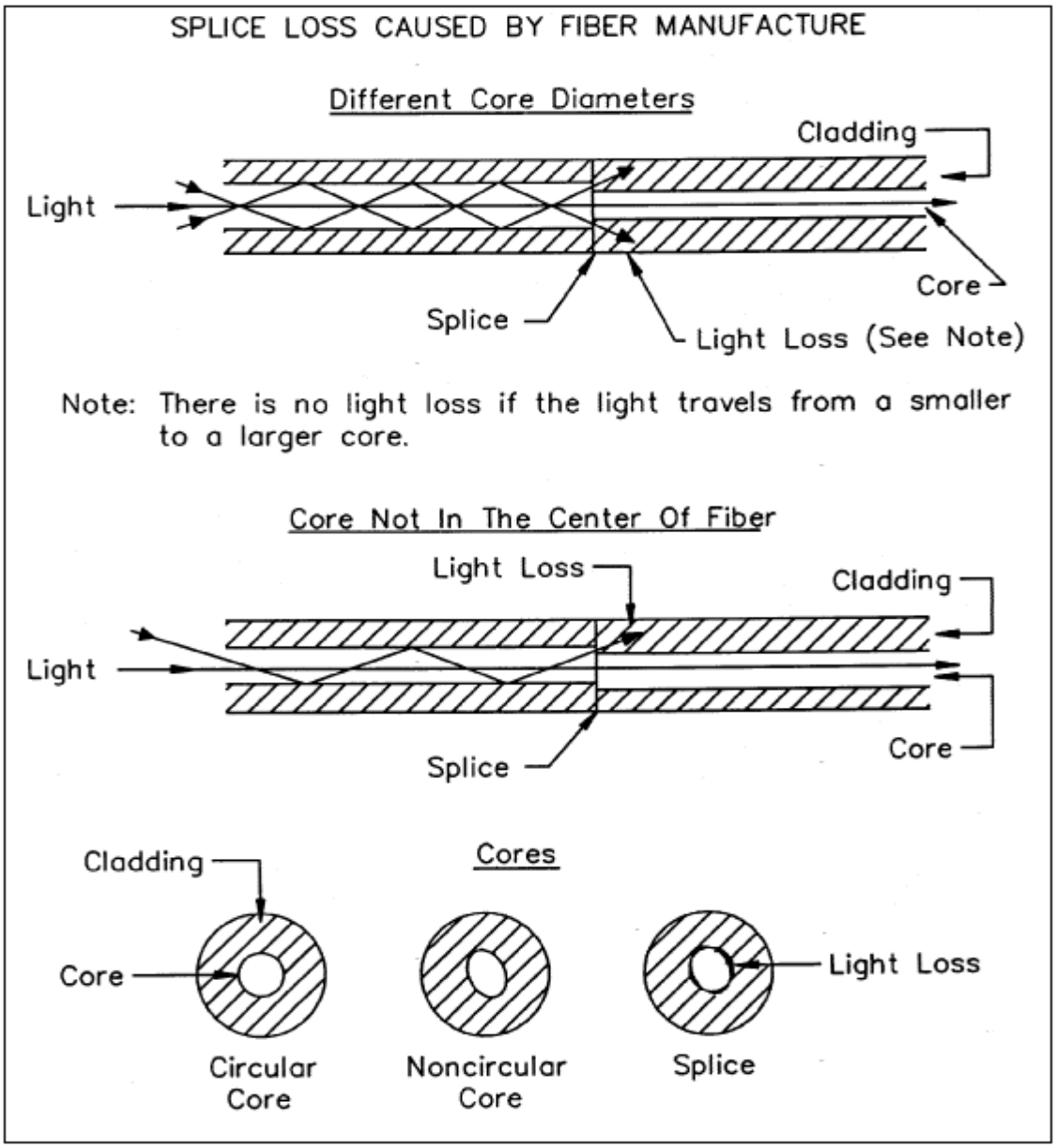


**Figure 2 - Splice Loss**

5.2.1.6 The cable manufacturer's recommendations concerning bending radius shall be observed. Unless the cable manufacturer's recommendation is more stringent, the minimum bending radius for fiber optic cable shall be 20 times the cable diameter.

5.2.1.7 The cable manufacturer's recommendations concerning buffer tube bending radius shall be observed. Unless the cable


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manufacturer's recommendation is more stringent, the minimum bending radius for buffer tubes is usually between 38 mm (1.5 in.) and 76 mm (3.0 in.). The bending limitations on buffer tubes are intended to prevent kinking. Buffer tube kinking may cause excessive optical loss or fiber breakage.

5.2.1.8 Fiber Optic Color Code: The standard fiber optic color code for buffer tubes and individual fibers shall be identical for the cables to be spliced and in accordance with 18-SAMSS-625 as shown in Table 1. Splicing shall follow this scheme.

**Table 1 - Fiber and Buffer Tube Identification**

| Buffer Tube and Fiber No. | Color | Buffer Tube and Fiber No. | Color |
|---|---|---|---|
| 1 | Blue | 13 | Blue/Black Tracer |
| 2 | Orange | 14 | Orange/Black Tracer |
| 3 | Green | 15 | Green/Black Tracer |
| 4 | Brown | 16 | Brown/Black Tracer |
| 5 | Slate (Gray) | 17 | Slate (Gray)/Black Tracer |
| 6 | White | 18 | White/Black Tracer |
| 7 | Red | 19 | Red/Black Tracer |
| 8 | Black | 20 | Black/Yellow Tracer, or Natural/Black Tracer |
| 9 | Yellow | 21 | Yellow/Black Tracer |
| 10 | Violet | 22 | Violet/Black Tracer |
| 11 | Rose | 23 | Rose/Black Tracer |
| 12 | Aqua | 24 | Aqua/Black Tracer |

5.2.1.9 OSP fiber optics (FOC) splicing and closure requirements stated on SAES-T-624 shall be meet.

5.2.1.10 Tools for Splices

In addition to the normal splicing tools, the following materials shall be required:

(1) Optical fiber splicing kit
(2) Lint-free tissue
(3) Approved cleaver tool
(4) Means of communication


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5.2.1.11 Splices - Methods, Tests and Cautions

Splice fibers with approved fusion splicing equipment or approved mechanical splices. Fiber optic splices shall be tested for splice loss as splices are being made, using an approved optical time domain reflectometer (OTDR) or local injection detection (see SAES-T-634 for test and acceptance requirements).

*CAUTION:*

*All fusion splices shall be made outside maintenance holes and at least 3 meters away from the maintenance hole opening. Mechanical splices may be made either in or out of maintenance holes.*

5.2.1.12 Preparations for Splices and Other Requirements

Before beginning the splicing operation:

(1) Secure the cable in an optical fiber splice organizer.

(2) Bond and ground all metallic members of the cable. The measured ground resistance shall be 25 ohms or less.

(3) To prevent fiber damage, handle buffer tubes and fibers carefully, when bending and placing in the organizer.

Comply with the following when splicing fiber optic cables:

(1) When splicing the fibers, follow the manufacturer's instruction for the splicing equipment being used.

(2) Use an approved buffer stripper.

(3) The fiber coating stripper used shall be approved for the specific size fiber being stripped.

(4) To minimize damage to the bare fiber, avoid excessive wiping (more than five times). Before cleaving, wipe the fiber twice with a new tissue dampened with 90% grade alcohol to remove any coating debris from the stripped fiber.

(5) Cleave the fiber with an approved cleaving tool. Do not use hand scribes for cleaving.

(6) If required, wipe the fiber after cleaving to remove dirt or grease. Avoid excessive wiping.


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### 5.2.2 Copper Cables Consideration

This section specifies the minimum requirements of splicing communications copper cables.

5.2.2.1 The following standard shall be apply:

(1) BULLETIN 1753F-401, RUS Standard for Splicing Copper

*Commentary Note:*

*Splicing requirements for Fiber Optics cables (FOC) shall comply with Section 5.1.1 on this standard.*

(2) BICSI (OSPDM): Outside Plant Design Reference Manual (Latest Version)

(3) BICSI (TDMM): Telecommunications Distribution Methods Manual (Latest Version)

Below are the minimum requirements that shall be meet adhere to splicing copper cables;

5.2.2.2 Splice Connectors

(1) Only filled splice connectors shall be used on outside plant projects. The following list of splicing materials / connectors is the most widely used for splicing polyethylene conductors:

- UR types connectors
- UG types connector
- PICABond types connectors

(2) The UR connector can be used to insulate, butt splice, and seal any two or three 19, 22, 24, or 26 gauge cable conductors. The UG connector can be used for tap splices.

5.2.2.3 Splice Connectors Crimp the connector with a standard E9 crimping tool (E9-E or E9-Y) until the cap of the connector is flush with the connector base as shown in Figure 3.


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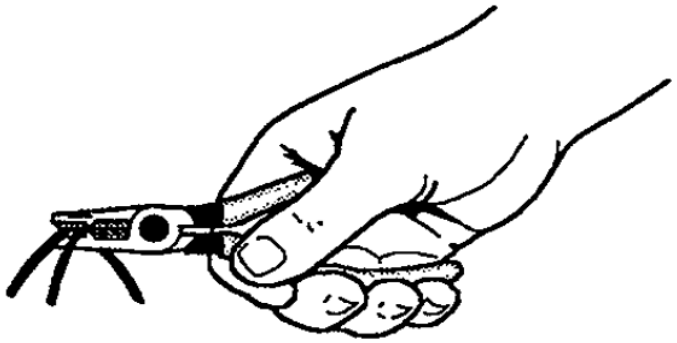

**Figure 3 - E9 Crimping Tool**

5.2.2.4 Twist each spliced pair loosely four times to prevent them from separating. Use the following illustration shown in Figure 4 as a reference to apply twists to conductors.

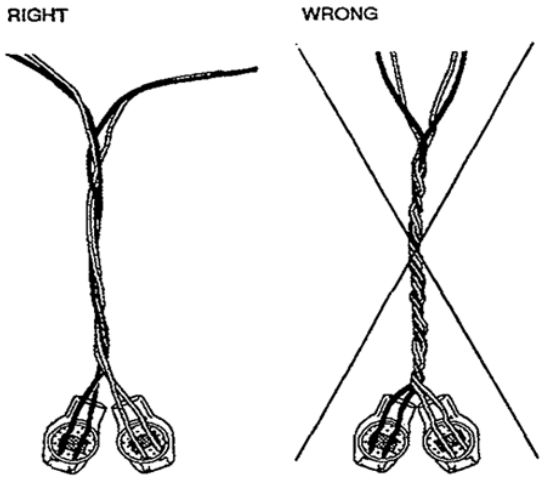


**Figure 4 - Twists to Conductors**

5.2.2.5 The PICA Bond or AMP connector is smaller than the Scotchlok connectors. The use of a Picabond connector results in a much smaller splice bundle. This smaller splice bundle is very desirable in high pair count cables. The Picabond connector is available with sealant for through and bridge connections in a butt splice configuration. See Figure 5 for various combinations of conductors using Picabond connector.


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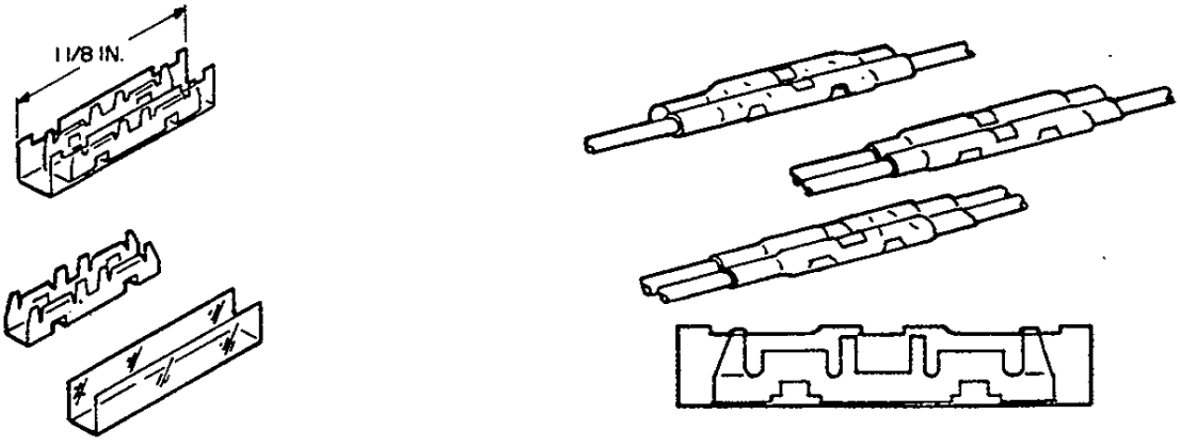


**Figure 5 - A-MP Connector Shown Joining Various Combinations of Conductors**

5.2.2.6 The crimping tool is designed to hold, cut the conductors, and crimp the connector in one operation. The crimping tool may be used separately as a hand held tool (Figure 6) or placed in the holder. The holder, however, should be used whenever making splices of 100 pairs or more.

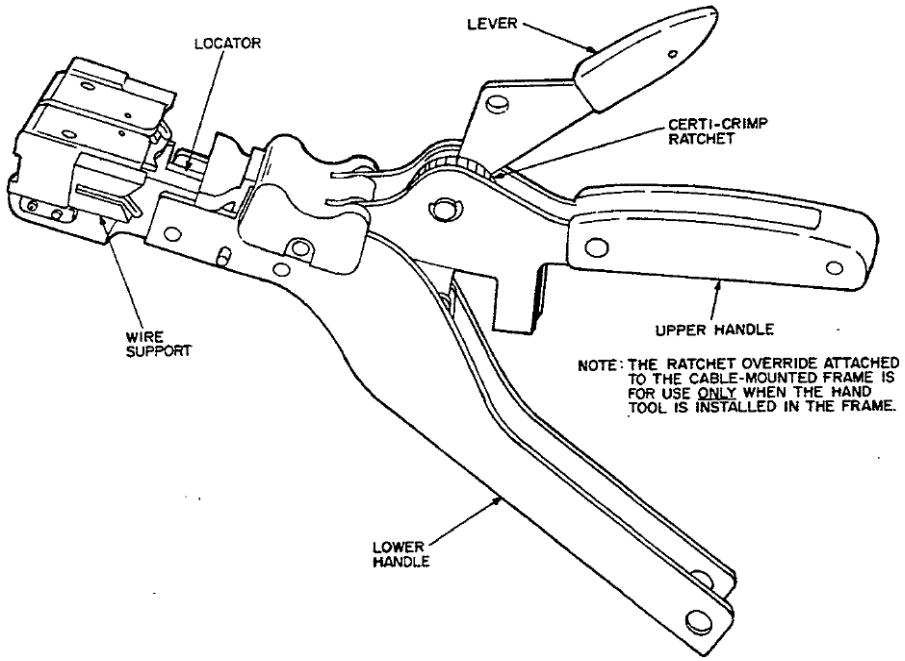


**Figure 6 - Crimping Tool**

5.2.2.7 Each Picabond connector consists of a preassembled two-piece housing (contact retainer housing and wire entry housing) and an insulation displacement contact. This contact will accept


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solid copper conductors in any combination of 19 through 26 AWG in the conductor holes. This conductor is crimped with a standard crimping tool.

5.2.2.8 It is necessary that at least one connector be checked for mechanical quality of crimp, with the crimp gauge as shown in Figure 7, at the beginning and end of each shift and after every 25 pairs are connected.

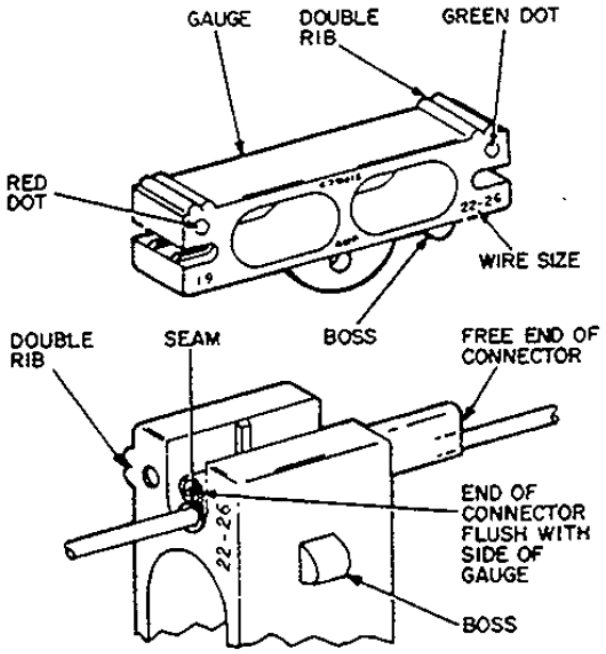


**Figure 7 - Connector Crimp Gauge**

Gauging Crimped Connectors procedure:

(1) First, select the proper gauge end: each end is stamped with the wire size it accepts; each end has a color dot to match the connector's color.

(2) Notice the seam in the connector and the double rib on the gauge. Push the connector into the gauge so that its seam faces the double rib. Place the connector so that its end is flush with the side of the gauge

(3) Hold the free end of the connector and release the gauge. It might fall off the connector. If it does, repeat the test on the other end of the connector.

(4) If either ends of the connector sticks in the gauge, the connection may be defective or insufficient pressure


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applied during crimping. Re-crimp the connector just gauged and gauge it again. If the connector passes the gauging, go back and re-crimp all the connections made since the last good gauging.

(5) Any connectors that fail the preceding inspection procedures must be replaced. Use the A-MP hand tool to re-crimp or replace all defective connectors.

*Commentary Notes:*

1. *Defective crimping and gauging tools must be removed from site and replaced with good quality ones and not used on any cable splicing until they are repaired.*

2. *When two cables are being spliced together, it is necessary to maintain the correct polarity for all individual cable pairs being spliced throughout the entire cable span. The tip conductors of one cable must be spliced to the tip conductors of the other cable and the ring conductors of one cable must be spliced to the ring conductor of the other conductor.*

5.2.2.9 Cable numbering and count identification minimize the chance of error during a cable transfer. Cable pairs that are energized are identified by numerical designations, and dead pairs are identified by alphabetical designations. Cable designations, as presented in Figure 8, shall be shown on the construction drawings as per SAES-T-018 and include the following parts:

- Cable Type Designation
- Cable Number Designation
- Dead Pair Designation

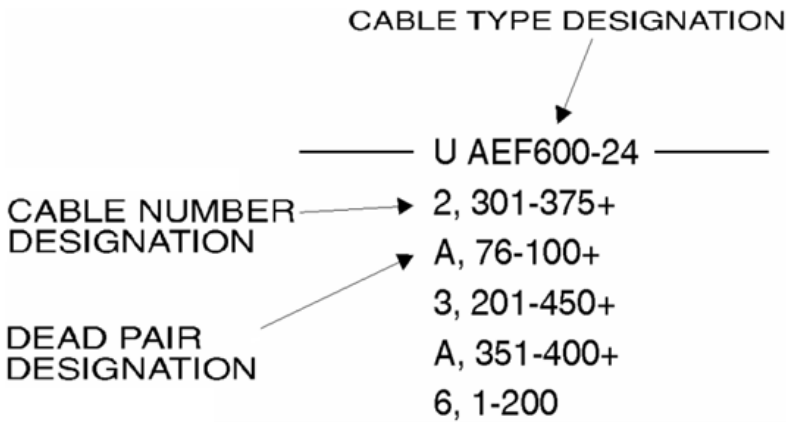


**Figure 8 - Cable Designation**


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5.2.2.10 All Saudi Aramco cables shall be even count color coded plastic insulation cables (PIC). Standard binder group to binder group, color to color splicing is the only type of splicing that is used by Saudi Aramco. This section covers the following methods for copper cable splicing:

(1) Straight Splices

Telecommunication cable of the same size can be joined through the use of a straight splice. A straight splice joins like color binder groups only, and the cable pairs are joined color to color. All binder groups are marked at both ends of the straight splice. The straight splice as shown in Figure 9 joins, by means of a connector, the matching cable pair conductors (ring to ring and tip to tip) from one cable to another cable to form a complete circuit. The cable pair conductor must be seated firmly against the stop to ensure a satisfactory electrical connection.

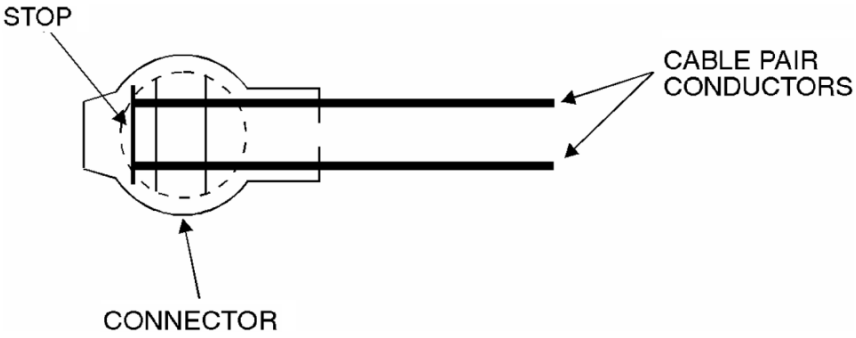


**Figure 9 - Straight Splice**

(2) Butt Splices

Bridge and tap connections can be accomplished through the use of butt splices. The bridge connection joins three or more cable pair conductors (ring-to-ring or tip-to-tip) to form a parallel circuit. The bridge connection, or half tap connection, as shown in Figure 10, joins three cable pair conductors through the use of a connector. The cable pair conductors must be set firmly against the stop to ensure a satisfactory electrical connection.


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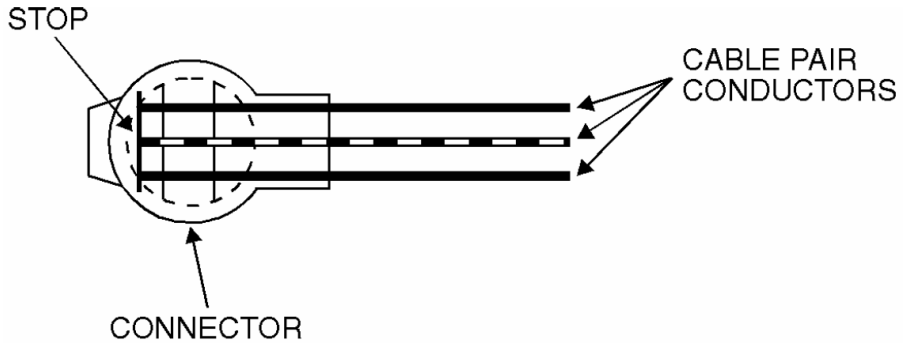


**Figure 10 - Bridge Connection**

5.2.2.11 Cable Tag

(1) All outside plant cables, copper or Fiber Optic, shall be identified with the proper designation using cable tag. Each tag must be stenciled with an arrangement of letters and/or numbers as indicated on the design drawings.

(2) Figure 11 shows the types of tags made from sheet metal that are used for cable identification at MH, pedestals and telecommunications rooms. Any equivalent tag may be used if approved by Area IT, OSP supervisor.

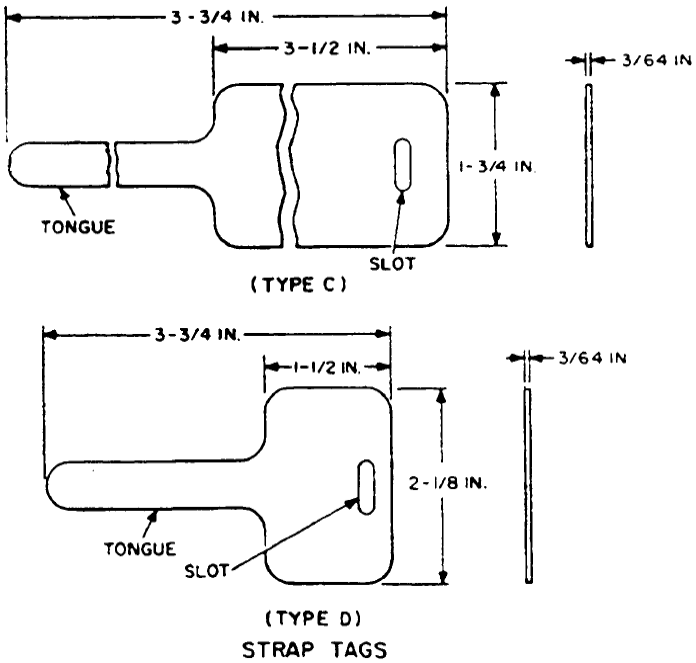


**Figure 11 - Cable Tag**


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5.2.2.12 Tags must be placed on the cables between the point where they emerge from a duct and the first cable rack. A tag must be placed on lateral cables as well as on the main cable.

5.2.2.13 The strap-type tag is placed around the sheath and the tongue pulled through the slot and bent back on itself (Figure 10). The C-type strap tag (Figure 12) is used on cables having a diameter of 1 inch or more. The D-type tag (Figure 9) is used on cables with a diameter of less than 1 inch.

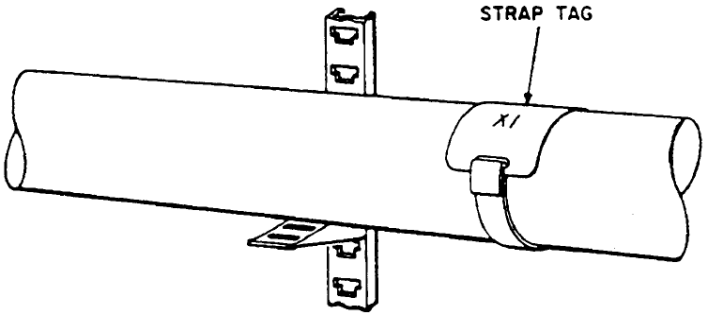


**Figure 12 - Strap Tag**

5.2.2.14 Splice Arrangements for Copper Cables

(1) Buried Splices

Direct buried splice cases accommodate straight splices, branch splices, and load coils. Direct buried splices shall be nonmetallic filled type and shall be used only when above ground splicing inside cabinets or pedestals or inside maintenance holes is not practicable. Refer to splice cases/closures on this standard for material details on direct buried splice/closure.

(2) Concreate tiles or blocks shall be placed 15 cm (6 in.) above the buried splice case to prevent damage to the splice case from future digging. If the soil below the splice does not form a firm base, a concreate slab or block shall be placed beneath the splice case. The concrete tiles or blocks shall be painted with orange color for identification as telecommunication system.

(3) Each buried splice shall be identified for future locating. One method of marking the splice point is the use of a marker post with a warning sign. Another method is the burying of an electronic locating device such as Electronic Marking System (EMS) markers.


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(4) Cable Cabinets and Pedestals

Cabinets and pedestals are housings primarily intended to house, organize, and protect cable terminations incorporating splice connectors, ground lugs, and load coils. Activities typically performed in pedestals are cable splicing, shield bonding and grounding, loading, and connection of subscriber service drops.

Typical splice capacities for cabinets and pedestals in Saudi Aramco are shown in Table 2. However, larger size pedestals are permissible if service requirements dictate their usefulness.

**Table 2 - Saudi Aramco Typical Pedestals and Cabinets Splice Capacities**

| Pedestal Type | Maximum Splice Pair Capacity | 9COM | Description |
|---|---|---|---|
| TYPE 1 | 400 Pair | 6000001102 | Pedestal Components/Hardware – CAD 6 |
| TYPE 2 | 900 Pair | 6000001140 | Pedestal Components/Hardware - CAD 8 |
| TYPE 3 | 1800 Pair | 6000012175 | Pedestal Components/Hardware - UPC 1000 |
| TYPE 4 | 2700 Pair | 6000001215 | Pedestal Components/Hardware - CAD 12 |

(5) Underground Splices (Maintenance Holes)

a. Underground splice cases accommodate straight splices, branch splices, and load coils. Underground splices shall be filled.

b. Precautions shall be taken to prevent the ingress of moisture and other contaminants during all phases of the splicing installation. When an uncompleted splice must be left unattended, it shall be sealed to prevent the ingress of moisture and other contaminants. All underground splice openings that require temporary protection, regardless of cable size, shall be covered with CR tape. All underground CR tape coverings shall be flash-tested for leaks along the seams and at the cables.

## 5.3 Cases/Closures Consideration

5.3.1 Splice Cases that are equipped to receive encapsulating compound, shall only be used on aerial and inside building cables.


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*Commentary Note:*

*Aerial application is not recommended and it's is use only for temporary applications.*

5.3.2 Direct buried and underground closure provide housing for splice and bonding and grounding. This shall be designed to restore the sheath mechanical integrity and electrical properties. Communications cables may enter this closure from one or both ends.

5.3.3 Whether used on filled or air core type cables, or whether splices are buried or underground, the closure must be filled with a re-enterable encapsulating compound. Installation shall be in accordance with the manufacturer's instruction, see BICSI OSPDRM 6th edition standard for reference.

5.3.4 Heat Shrinkable Splice Closures

Heat shrinkable splice sleeves and closures are generally available locally. Listed below are brief descriptions and uses of some locally available Heat-Shrinkable (Thermo fit) Sleeves (Closures). The list below is not comprehensive, but is typical of what is available in this type closure.

- 102L:

  Heat-shrinkable caps for sealing cable ends in non-pressurized or low performance pressurized applications. It is a medium-wall molded cap internally coated with an adhesive or mastic sealant. The end cap is available in sizes to fit cables that range from 4 mm to 115 mm diameter. For installation, the cap is centered over the ends of the cable and heat shrunk to form a seal of the cable ends.

- XAGA 200:

  Consists of a heat-shrinkable wrap around sleeve with a stainless steel channel closure and a pre-formed non-hydroscopic laminate to insulate, compact, and shape the splice. To insure proper installation the wrap around sleeve is coated externally with a heat-sensitive paint that changes color when enough heat has been applied for proper installation. XAGA 200 has a splice capacity up to 200 pairs (.6 mm/22 AWG) in configurations up to three cables in and three cables out and is used for sealing and protection of unpressurized cable splices.

- XAGA 200R:


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Is used for the sealing and protection of cable splices in the unpressurized telephone distribution network. A variable liner provides a laminated aluminum barrier against moisture vapor transmission as well as mechanical protection for the splice bundle. The shrinkable wrap around sleeve forms a watertight seal to the cable jacket. Up to three cables can enter each end of the sleeve. Each kit comes complete with filling compound for protection from water ingress. This sleeve comes in four sizes and can be used on a splice with a maximum of 120 mm diameter.

- XAGA 250:

  Is used to seal telephone cable splices for filled or unpressurized air core cable. This wrap around, heat-shrinkable splice closure will accommodate in-line as well as branch splices on polyethylene or lead sheath cable. It may be used for direct buried, aerial, and underground installations. It provides a watertight seal that is also re-enterable for cable repair and rearrangements. It is constructed of a material formulated to resist UV radiation and atmospheric contamination. A splice encapsulation kit does not come with the XAGA 250, but is available in a separate kit. The XAGA 250 comes in different sizes and can be used on splices with maximum diameters of 200 mm.

- WRST:

  Wrap-around repair sleeves are split sleeves closed by a slide-on metal channel. WRST sleeves are suitable for all types of cables in direct buried, underground, or aerial applications. It is designed for use over transitions in a cable where a large shrink ratio is required. This sleeve is suited for repairing all types of sheath openings and sheath damage (trouble openings, fire and steam damage, cable bend repair, and etc.). It comes in several sizes and can be used on cables from 10 mm to 190 mm diameter.

5.3.5 On underground and buried cable splices, Saudi Aramco uses splice cases in which the splice can be encapsulated.

5.3.6 The Preformed Stainless Steel Splice Closure (a non-filled type splice closure) or equivalent may be used on underground cables when the splice will be located inside a manhole. This type installation may require an annual preventive maintenance program (pressure test of splice closures, etc.) for verification of splice integrity. Installation materials and procedures shall comply with the manufacturers' recommendations.


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5.3.7 All direct buried or underground cable splice closures shall be filled with a re-enterable encapsulating compound on air core as well as filled cables. The splice closure used shall be a type that is manufactured to hold encapsulating compound. The Pressure Wrap Kit, or a similar product utilizing a perforated web liner, shall be used in all encapsulated re-enterable splice closures.

5.3.8 Closure Configurations

Splices closures are both used in copper and fiber optic applications and they can be pressurize, non-pressurize, filled and non-filled. They are typically to secure and protect cables and splices. Provide strain relief and allow for re-entry. The splice closure are classified according to the configuration of cables that enter the closure such as,

- Straight, Branch
- Butt
- Universal.

Refer to BICSI OSPDM - Outside Plant Design Reference Manual (latest version) for additional requirement to comply.

The design engineer shall clearly identify and specify the proper size and type splice closure on the IFC drawings. And all splice closures materials used in Saudi Aramco on Outside Plant (OSP) projects shall be of filled type.

*Commentary Note:*

*Requirements for Fiber optic cables (FOC) shall comply with 18-SAMSS-625 and Copper cables shall comply with SAES-T-920.*

5.3.9 Additional Requirements to be Consider

5.3.9.1 Fiber Optics Cables

(1) Typical fiber optic (FO) splice closure are define in BICSI OSPDM - Outside Plant Design Reference Manual (latest version)

*Commentary Note:*

*Manufacturer specifications should be consulted for splice closure capacity.*

(2) Typical copper cable splice closure are define in BICSI OSPDM - Outside Plant Design Reference Manual (latest version)


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(3) Cables Splice Organizers

Non-metallic splice organizers shall be used for organizing fibers at splice points. Installation shall be in accordance with the manufacturer's instructions.

(4) Cleaving Tools

An approved Universal Fiber Optic Cleaving Tool shall be used in cleaving fibers. All cleaving tools shall be used according to the manufacturers' instructions.

5.3.9.2 Copper Cables

Typical balance twisted-pair splice closure are define in BICSI OSPDM - Outside Plant Design Reference Manual (latest version).

# 6 Installation

## 6.1 Cable Splicing

6.1.1 Cable splice locations and other splicing details should be specified in Issued for Construction (IFC) drawings in accordance with SAES-T-018.

6.1.2 The installation instructions provided by the manufacturer of splicing materials shall be followed except where those instructions conflict with the procedures specified in this standard.

6.1.3 All applicable safety precautions and Loss Prevention standards must be adhered to in the use and installation of the Cable Repair Auto wrap. Choose with care the locations in which this repair method will be used, due to the presence of heat and 120 volt electrical source. Comply with NFPA 70 safety precautions.

## 6.2 Splice Closure

6.2.1 Cable splice closures shall be installed in accordance with the manufacturer's instruction unless directed otherwise in this Standard.

6.2.2 All splice cases installed on feeder cables shall be filled, whether buried, or underground.


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# 7 Testing and Inspection

## 7.1 Cable Splicing

7.1.1 Copper and fiber optic cable testing and acceptance shall be performed in accordance with the standard SAES-T-634. The tests and inspections shall be witnessed by the proponent representative, Inspection Department and other involved stakeholders.

7.1.2 The OTDR and optical power meter tests shall be conducted for end-to-end cable acceptance tests for fiber optic cables (FOC). Also, CD and PMD test results for specified cables under test shall submitted.

7.1.3 Inspection Department Notification: The Saudi Aramco Inspection Department shall be notified two working days prior to beginning any cable splicing or testing so that all necessary inspections can be scheduled. The Inspection Department shall be notified two working days prior to backfilling any trenches or starting any acceptance testing.

## 7.2 Splice Closure

7.2.1 All quality assurance (QA) Inspections shall be done by a qualified communications inspector. All splice closures shall be flash tested and inspected for proper seals. Buried and underground splices shall be inspected to assure proper fill (of encapsulating compound) in the closure and use of the recommended (by closure manufacturer) encapsulating compound.

7.2.2 All splice closures shall be flash tested and inspected for proper seals. Buried and underground splices shall be inspected to assure proper fill (of encapsulating compound) in the closure and use of the recommended (by closure manufacturer) encapsulating compound.

7.3 As-Built drawings: Shall be updated daily by field installation crew. As-Built drawings and acceptance tests results shall be provided to and approved by the Saudi Aramco Communications Engineering Division of IT before the Mechanical Completion Certificate (MCC) is approved.

7.4 Quality Assurance (QA): Quality assurance inspections shall be performed during all phases of construction by Saudi Aramco Inspection Department Inspector. Inspections shall be done by a qualified communications inspector.


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## Revision Summary

| | |
|---|---|
| 17 February 2015 | Major revision. The standard has been re-written to:<br>(1) include fiber cable splicing, and<br>(2) remove reference to GTE. |
| 18 October 2016 | Major revision consolidating two standards (SAES-T-632 and SAES-T-633) into one document as part of communications standards committee's optimization initiative. Such as it will in alignment with international standards, functionality, and technology evolution. It also provide better clarification and understanding to the standards users. |
| 7 May 2019 | Editorial revision as part of content confirmation assessment |


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