Engineering Standard

08 March 2021

SAES-T-624
Telecommunications: Fiber Optic Cables for Outside Plant (OSP) and Inter/Intra Building Applications

Document Responsibility: Communications Standards Committee

Previous Revision: 22 January 2018
Next Revision: 08 March 2026
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Contents

Summary of Changes

Paragraph Number		Change Type (Addition, Modification, Deletion)	Technical Change(s)
Previous Revision (22 January 2018)	Current Revision (08 March 2021)		
1	1	Modification	Modify the scope for clarity
2	2	Modification	Section was modified to aligned with EK&RD requirements
3.1	3.1	Addition	SAES-J-903 standard was added to aligned with the above ground requirements
			SAES-T-018 standard was added to aligned with the Telecommunications symbols, ans etc.
			Saudi Aramco Safety Management System (SMS) was added
			Saudi Aramco Construction Safety Manual was added
		Modification	Editorial change of the SAES-T-916 standard title
		Deletion	Saudi Aramco Construction Safety Manual was deleted
3.2	3.2	Addition	EIA/TIA-568.3-D: Optical Fiber Cabling Components Standard
		Modification	Editorial chage of EIA/TIA-569-E, from version D to version E
			Editorial chage of BICSI TDMM to 14th edition
			Editorial change of BICSI OSPDRM to 6th edition
5.1.4	5.1.4	Modification	Editorial change to address the RCDD certification requirement prior to IFC.
5.2	5.2	Deletion	Deleted the write-up under this section.
5.2.1.1	5.2.1.1	Modification	Editorial change of the sub-section title
5.2.1.2	5.2.1.2 (1) (2) (3)	Addition	- Bullet 1 (f): cable types identification as per ITU-T standards - Referencing to a figure for clarity, which address the trench drawing in details.
5.2.1.3	5.2.1.3	Modification	- Editorial by adding the word “fiber optic” which applies to new cabling. - Bullet 3: Defining the meaining of “aerial construction” as per BICSi definition. - Editorial change in the last paragraph by referenicng the SASD Standard Drawing AA-036748, Buried Telephone Cables/Distribution Wires, SAES-T-911 and SAES-T-928 standards, and deleted the commentary note.
5.2.1.4	5.2.1.4	Modification	Editorial change by specifying the OSP FO cables
5.2.1.5	5.2.1.5	Modification	Defined the requirement of the armored cable type/application, and allowing the used of cable tray for above ground installation.
5.2.2.3	5.2.2.3	Modification	Editorial change address grounding requirements
5.2.3.2	5.2.3.2	Modification	Editorial change by replacing the SAES-T-629 to SAES-T-911 standard.
5.2.3.4	none	Deletion	Deleted the direct buried installation requirement using rigid PVC.
5.2.3.5	5.2.3.4	Modification	Modified section to address the color coding of suducts for HDPE corrugated, built-in 5 pcs. subduct, and referecing SAES-T-911.
5.2.3.6	5.2.3.5 (7)	Addition	Added the 20% growth requirements of spare subducts plus one spare conduit, also, it applies to shared ductbank.
5.2.3.7	5.2.3.6 (2)	Addition	Added the requirements of the HDPE pipes with corrugated wall and built-in subduct installtions.

5.2.4.1	5.2.4.1	Modification	Added requirements address to PVC conduit and HDPE pipes, solid wall.
5.2.4.8	5.2.4.8	Modification	Editorial changes to specify OSP FO cables type
5.2.4.13	5.2.4.13	Modification	Editorial changes by referencing the right standards address to FO cable installations requirements and applicable safety practices.
5.2.5.2	5.2.5.2 (6)	Modifcation	Added requirements for the EMS testing and it shall be in accordance with manufacturer's instruction.
5.2.5.5	5.2.5.5	Modification	For clarity, the section was modified to aligned with the Saudi aramco standards such as, SAES-T-911 and SAES-T-928.
5.2.5.6	5.2.5.6	Modificatioin	For clarity, the section was modified to aligned with the Saudi aramco standards such as, SAES-T-911 and SAES-T-928.
5.2.5.8	5.2.5.8	Modificatioin	For clarity, the section was modified to aligned with the SAES-T-795, grouniding system.
5.2.5.9	5.2.5.9	Modificatioin (2)	For clarity, the section was modified to aligned with the Saudi aramco standards such as, SAES-T-911.
5.2.5.9	5.2.5.9	Modificatioin (5)&(6)	For clarity, the section was modified to aligned with the Saudi aramco standards such as, SAES-T-911, SAES-T-928, & SAES-L-450
5.2.6	5.2.6	Modification	For clarity, the section was modified to address aerial construction
5.2.6.1 – 5.2.6.7	5.2.6.1 – 5.2.6.7	Deleted	For clarity, the section was modified to address aerial construction
5.2.8	5.2.8 (7)	Addition	Add requirements to address the “Total no. of splices and total no. of connectors”, also requires a table for the “Link Loss Budget Calculation”.
5.2.9	5.2.9 (5)	Modification	Add requirements address to the spare fiber strands for each fiber counts
none	5.2.10	Addition	Add requirements address to fiber optic sizing
5.3.1	5.3.1 Commentary note	Addition	Specify requirements for SM fiber optic and MM fiber optic
5.3.2	5.3.2	Modification	Aligned with 18-SAMSS-625
5.3.3	none	Deleted	Section deleted, these requirements are duplicated in SAMSS.
none	5.4	Addition	Added section in regard to “Fiber Optic Connectors”
none	5.5	Addition	Added section in regard to “Circular Economy”
6	6	Modification	Editorial
7.1	7.1	Modification	For clarity, removed mechanical splicing loss
7.7	7.7	Modification	Editorial, to reflect the Red-line drawing requirement

1 Scope

This standard covers mandatory requirements governing the engineering, design, and installation of fiber optic cable systems for the following applications;

1.1 Outside Plant (OSP)

Single Mode Fiber Optic Cable shall be use for Outside Plant (OSP).

1.2 Inter and Intra Building

Multimode Fiber Optic Cable and Single Mode Fiber Optic Cable shall be utilized in inter and intra building installations for all data communications and Local Area Network applications.

2 Conflicts and Deviations

Any conflicts between this document and other applicable Mandatory Saudi Aramco Engineering Requirements (MSAERs) shall be addressed to the EK&RD Coordinator.

Any deviation from the requirements herein shall follow internal company procedure SAEP-302.

3 References

All referenced specifications, standards, codes, drawings, and similar material are considered part of this engineering standard to the extent specified, applying the latest version, unless otherwise stated.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-302	Waiver of a Mandatory Saudi Aramco Engineering Requirement

Saudi Aramco Engineering Standards

SAES-J-902	Electrical Systems for Instrumentation
SAES-L-450	Construction of On-land and Near-shore Pipelines
SAES-P-111	Grounding
SAES-T-018	Telecommunications - Symbols, Abbreviations, and Definitions
SAES-T-629	Telecommunications Outside Plant - Copper Cable
SAES-T-632	Telecommunications: Splicing Copper Cables, Fiber Optic Cables, and Types of Splice Closure

SAES-T-911	Telecommunications Conduit System Design
SAES-T-916	Telecommunications- Building Cable Systems, Pathways and Spaces
SAES-T-919	Submarine Fiber Optic Cable
SAES-T-928	Telecommunications-OSP Buried Cable

Saudi Aramco Materials System Specification

18-SAMSS-625	Outside Plant - Fiber Optic Cable Specifications (Single Mode & Multiple Mode)

Saudi Aramco Standard Drawings

AA-036748	Buried Telephone Cables
AB-036897	Buried/Underground Cable Route Marker Posts and Signs

Saudi Aramco Safety Management System (SMS)

Saudi Aramco Construction Safety Manual

3.2 Industry Codes and Standards

International Telecommunications Union – Telecommunications Standardization Sector (ITU-T)

G.651	Characteristics of a 50/125 Micrometer Multimode Graded Index Optical Fiber Cable
G.652	Characteristics of a Single-Mode Optical Fiber Cable
G.653	Characteristics of a Dispersion-Shifted Single-Mode Optical Fiber Cable
G.655	Characteristics of a Non-zero Dispersion Shifted Single-Mode Optical Fiber Cable

American National Standard Institute

ANSI/NFPA 70	National Electrical Code (NEC)

Electronic Industries Association

EIA/TIA-568.3-D	Optical Fiber Cabling Components Standard
EIA/TIA-569-E	Telecommunications Pathways and Spaces

Building Industry Consulting Service International

BICSI TDMM	Telecommunications Distribution Methods Manual – 14th edition

BICSI OSPDRM Outside Plant Design Reference Manual – 6th edition

4 Terminology

4.1 Acronyms

GPR ground potential rise
OSP outside plant
OTDR optical time domain reflectometer

4.2 Definitions

Attenuation: A measure of the decrease in energy transmission (loss of light) expressed in decibel (dB). In optical fibers, attenuation is primarily due to absorption and scattering losses.

Aerial Cable: A cable that is suspended in air, such as pole-to-pole, building-to-building or pole-to building (building exteriors in particular).

Coating: A layer of composite plastic material covering the fiber to provide mechanical protection.

Core: The glass central region in an optical fiber that provides the means for transmitting light.

Long Haul: Cabling and telecommunications circuits that span a considerable distance (long distance), well beyond the range of a campus.

Multimode: A fiber that allows more than one optical mode to propagate.

Single Mode: A fiber that supports the propagation of only one mode.

Operating Wavelength: The light wavelength at which a system is specified, normally expressed in nanometers (nm). Most single mode fibers can operate at 1,300 nm or 1,550 nm.

Optical Link Loss Budget: Total losses allowed for satisfactory operation of an optical fiber system.

Pigtails: Small single fiber cords used to terminate optical fiber cables at Central Offices (COs) or regenerators. Each has a connector at one end to interface the equipment and a bare fiber at the other end for splicing to a fiber in the main cable.

Splice Loss: The amount of loss of light energy caused by angular misalignment, and/or fiber end separation, and/or lateral displacement of fiber axes.

5. Design

5.1 General Requirements

5.1.1 OSP Design Reference

The BICSI Outside Plant Design Reference Manual (OSPDRM latest edition) is hereby recognized as the referenced detailed design information.

5.1.2 For Inter and Intra Building Design Reference

The BICSI TDMM (latest edition) is hereby recognized as the referenced detailed design information.

5.1.3 Design drawings shall use conventional symbols as specified in the SAES-T-018 Telecommunications - Symbols, Abbreviations, and Definitions.

5.1.4 Designer Certification Requirements

5.1.4.1 All telecommunications system designs by non-Aramco design offices (such as GES Contractor, LSTK, etc.) must be done under the design authority of a valid/current BICSI Registered Communications Distribution Design (BICSI RCDD and/or OSP Specialty). This is to ensure that a minimum level of competency has been provided in the telecommunications infrastructure and OSP pathways and spaces. For external design contractors, the RCDD and/or OSP shall be a direct employee of that company.

5.1.4.2 All related design drawings shall be reviewed and stamped by a valid certified RCDD and/or OSP designer during the detailed design before the package can be Issued for Construction (IFC).

5.2 Outside Plant (OSP) Consideration

5.2.1 General Requirements

5.2.1.1 Design Documentation

As a part of each telecommunications work order/project, detail schematic drawings shall be prepared for each fiber optic span/cable route, showing the following information:

1) Fiber Cable Data
   a) Cable manufacturer
   b) Vendor number

c) Cable size (number of fibers)
d) Cable type (filled or air core)
e) Cable make-up (dielectric or non-dielectric)
f) Type of fiber (multimode or single-mode), include ITU-T standard types.
g) Dispersion shifted or non-dispersion shifted
h) Transmission characteristics (dB loss/km at given wavelength and for multimode bandwidth/km)
i) Dispersion specification in ps/(nm . km)
j) Fiber packaging (single fiber/loose. Buffer; multiple fiber/loose buffer; tight buffer, channel/groove or ribbon type, and color code)

2) Other Information
a) Trunk number/cable number
b) Span number
c) Maintenance hole number and duct number
d) Wall-to-wall measurements (of conduits between maintenance holes)
e) Major intersections and key streets
f) Fiber cable splice points with station location
g) Splice-to-splice cable lengths
h) The footage and/or meter markings on the engineering design construction drawings
i) Change in cable route
j) All substructures (pipes, utilities, etc.) with station location.
k) Location of marker posts and signs

5.2.1.2 Design Drawings Classification

All fiber optic work order/project design drawings shall be composed of three basic groups of drawing classification for consistency in presentation and application of standard symbols and abbreviations and for convenience in execution and recording. This drawing shall be reflected during the detail design phase of the project such as, but not limited to, trenches in a traffic area and non-traffic areas, rocky areas, roads and streets (unpaved/paved), inside the plant facilities (requires mechanical protection), pipeline corridors, camel roads, and railroads. Refer to Saudi Aramco Standard Drawings:AA-036748.

1) Cable Drawing (Cable Schematic): Refer to Figure A and B below:
a) Cable layout shall have all the complete information symbolizing installation, removal or rearrangement of fiber optic cable, terminating equipment and other equipment associated with the

fiber cable. It shall also include address or location of the cable route and of the fiber terminal.

b) No part of a cable layout drawing shall refer to a detail layout in other sheets not associated with the cable layout.

c) Fiber cable shall be properly identified using applicable Saudi Aramco fiber cable designation symbols as specified in SAES-T-018. In addition, naming of cables shall be properly identify using Network Engineer through coordination with IT Engineering Department.

d) Fiber terminating equipment (panel) shall be symbolized by proper fiber terminal symbol as specified in SAES-T-018, indicating the terminal number, cable & count, and fiber terminating capacity.

e) All fiber cable related functions such as splicing symbol and sequence, fiber cable characteristics and parameters, test information and other directly cable related functions shall be contained in the cable drawing section.

f) Detail presentation or drawing of the fiber cable route, termination, and other cable details shall be shown in the section for “Detail Drawings.”

2) Trench Drawing (Trench Schematic): Refer to Figure A and B below:

a) The trench layout shall have complete information directly related to all trench and conduit work involved. This will include proposed trench, conduit, maintenance hole substructure symbols and other directly related symbols.

b) Trench section detail, maintenance hole layout and other detail drawings shall be shown in the section for “Detail Drawings.”

3) Detail Drawings (Detail Schematic): Refer to Figure A and B below:

a) This section shall contain drawings which show detail presentation on any part of the Cable or Trench drawing.

b) Any other drawings presented to enhance readability and layout presentation at the Cable and Trench Schematic shall be shown in this section.

c) Sectioning or grouping of the three different drawing classifications shall be on a sheet or drawing page basis. Work order drawings involving small size jobs may accommodate more than one section in a drawing sheet provided they are properly segregated by dividing lines and identified accordingly.

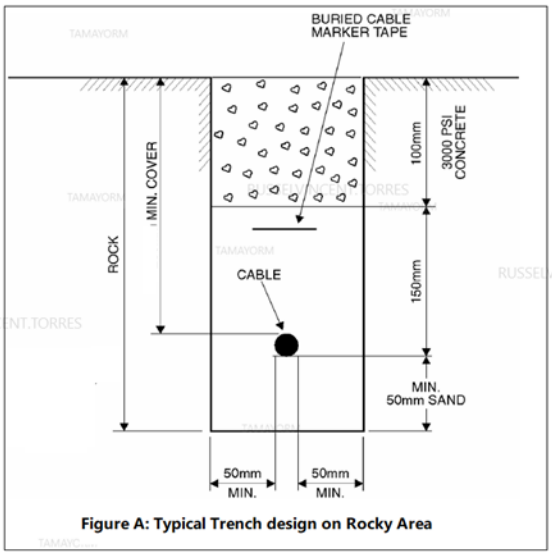

Figure A: Typical Trench design on Rocky Area

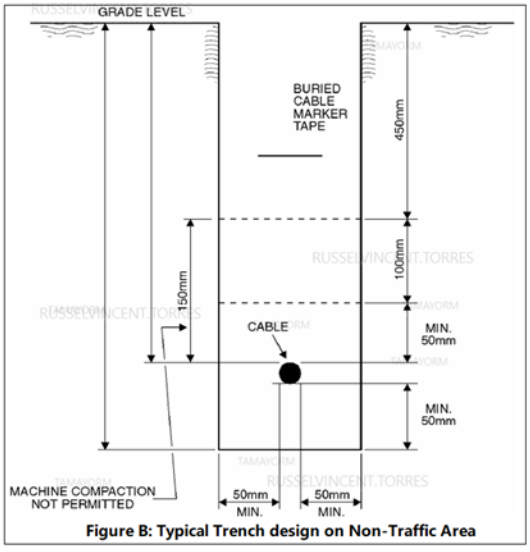

Figure B: Typical Trench design on Non-Traffic Area

5.2.1.3 Cable Route

The cable route for all new fiber optic cables shall be reviewed by the stakeholders e.g. AREA-IT, ITED, Plant facilities & Communications standard Chairman.

The Company approved construction or installation methods are as follows:

1) Underground (in conduit)
2) Buried (direct burial, i.e., not in conduit)
3) Aerial Construction

Note:
An aerial installation means a cable that is suspended in air, and aerial construction shall only be approved through a waiver, and shall comply with BICSI OSPDRM installation requirements.

All buried and underground cable routes shall be marked in accordance with Saudi Aramco Standard Drawing AB-036897, Buried/Underground Cable Route Marker Posts and Signs, SASD Standard Drawing AA-036748, Buried Telephone Cables/Distribution Wires, SAES-T-911 and SAES-T-928 standards.

Commentary Note:

In a situation where, above ground installation using cable tray is required, then it shall be reviewed by the stakeholders (e.g. AREA-IT or ITED and Communications Standards Chairman). In addition, the SAES-J-902 standard shall be a reference for cable tray and conduits installation.

5.2.1.4 Cable Characteristics

All Saudi Aramco OSP fiber optic cables shall comply with 18-SAMSS-625 specification.

5.2.1.5 Metallic Armor Use

Fiber optic cables may include an integral metallic armor if required for offshore applications. Refer to SAES-J-902 standard for cable tray and conduit installation requirements.

5.2.1.6 Composite Cable Use

Other types of fiber optic cables such as submarine cables (stand-alone fiber optic cable, and composite cable - power & fiber optic) shall not be used.

Commentary Note:

1) The submarine stand-alone and composite fiber optic cable requirements shall comply with SAES-T-919.
2) Optical Ground Wire (OPGW) fiber optic cable shall comply with 18-SAMSS-005. The used of OPGW for IT applications shall be reviewed by the stakeholder/s and Communications Standard Chairman.

5.2.1.7 Use of Different Cable Types

For an individual link, the fiber optic cable shall be of the same type to ensure the same performance characteristics. This is to ensure compatibility in terms of the fiber geometrical parameters, attenuation, and dispersion.

5.2.1.8 Bending Radius

The minimum bending radius for fiber optic cable is:

1) Ten (10) times the cable diameter when the cable is not under tension.

2) Twenty (20) times the cable diameter when the cable is under tension.

5.2.1.9 Pulling Tension

The pulling tension on fiber optic cables shall not exceed 600 pounds unless greater pulling tensions are specifically approved by the cable manufacturer. When fiber optic cable is pulled, it shall be pulled in a straight line. The cable shall never be bent or wrapped around the hand or any other object as it is pulled. Only vendor-approved equipment or methods shall be used.

5.2.1.10 Cable Environment

All environmental conditions (petroleum, petroleum-based products, thermal, chemical, mechanical, electrical conditions, etc.), which could be detrimental to the fiber optic cable when it is installed, shall be identified and all necessary action taken to protect the cable from the potential hazards in its environment.

5.2.2 Central Office and Remote Site Design Engineering

5.2.2.1 Cable Route in Buildings

The fiber optic cable route used from the central office cable vault (or building entrance) to the optical terminal equipment shall be designed in accordance with SAES-T-916, this cable route shall be shown on the telecommunications OSP design and construction drawings. The following guidelines shall be observed:

1) Do not use power cable runways (AC and/or DC) to support optical cables.
2) Install a new runway or conduit to support the planned optical fiber cable if an office:
   a) Is equipped with a cable grid only, and/or
   b) Does not have available existing cable troughs or race ways.
3) Optical fiber cables may be routed with high frequency (Coaxial cable) cable.
4) Avoid a route that would stack future cables in excess of 225 kg/m on top of fiber cables.
5) Do not exceed the fiber cable's minimum bending radius.
6) Provides adequate storage of cable slack, it shall have a coil/loop of 15 meters of slack cable in the cable vault or cellar and 10 meters if there is no cable vault for restoration.

5.2.2.2 Fire Protection Requirements in a Buildings

Fiber optic cables placed inside all buildings shall comply with the fire protection requirements of ANSI/NFPA 70, NEC Article 770, & IBC.

5.2.2.3 Grounding of Metallic Members of Cable in a Building

If fiber optic cables (with metallic member) entering a building, it shall be grounded in the point of entry. If metallic conduit is used, the conduit shall be bonded (at each end) to the fiber optic metallic members and connected to the building grounding busbar. Refer to SAES-P-111or SAES-T-795 for more details.

5.2.3 Subduct Engineering

5.2.3.1 Number of Subducts in Four Inch Conduit

A four (4)-inch diameter underground conduit that is being set up for fiber optic cable placement shall contain:

1) Three (3) pieces subducts composed of two (2) pieces of 1½ inches – inside diameter subducts and one (1) piece of one (1) inch - inside diameter subduct, or
2) Four (4) pieces of one (1) inch - inside diameter subducts.
3) Subducts shall have pull rope or pulling tape inside.
4) For High Density Polyethylene (HDPE) pipes:
   a) Corrugated Wall HDPE pipes: The Polyethylene Corrugated Ducts (PECD) or COD with factory built-in subducts is used for the underground infrastructure to host fiber optic cable. The requirements stated in the SAES-T-911 standard shall be comply.
   b) Solid Wall HDPE pipes: The PE 80 and PE 100, 110 mm diameter, black color with orange stripe shall be use, and the requirements stated in the SAES-T-911 shall be comply.

5.2.3.2 Subduct Placement

When placing subduct:

1) Comply with safety and installation requirements of SAES-T-911.
2) Do not allow the pulling length of underground subduct to 366 meters. This is aligned with the maximum length of main conduit section as per SAES-T-911.
3) Station additional personnel at pull-through maintenance holes to:
   a) Help guide subduct into the opposing duct.
   b) Alert the pulling personnel in the event of a mishap.
   c) Help with lubricating the subduct as it is pulled in.

4) Use a 380 mm minimum bending radius during installation. Refer to SAES-T-911 requirements pertaining to "Minimum Spacing between Cables and MH Ceiling" and "Minimum Space between Cables and MH Floor".
5) At pull through maintenance holes, conduit offset shall be 230 mm or less.
6) Lubricate the subduct throughout the pull by applying generous amounts of lubricant (use lubricant recommended by subduct manufacturer) at the:
   a) Feeding end
   b) Pull-through locations
7) In addition to the standard underground placing tools, the following special tools and equipment are required:
   a) Subduct reel(s)
   b) Lashing wire (to be used to secure cable grip on subducts)
   c) One-inch dowels or larger based on subduct size (wood or plastic) or scrap copper cable (to be used for plugging the pulling end of each subduct for a distance of 300-450 mm to prevent subduct from collapsing during the pulling operation)
   d) Portable two-way radios (minimum of two) or another reliable communications ability
8) Position subduct reels so that the subduct is alternately pulled from the top of one reel and the bottom of the next reel to keep the subducts from twisting during installation.
9) Plug all subduct ends to prevent water, dirt, etc., from entering the subduct.

5.2.3.3 Subduct Placement in Occupied Ducts

When optional fiber cables/subducts need to be placed in ducts occupied by other types of cables:

1) A minimum of two one-inch (2 x1") subducts shall be placed.
2) Copper cables shall not be pulled after the fiber has been installed.

5.2.3.4 Subduct Colors

The subducts, which are placed inside a four-inch conduit, shall be different colors, as following the color scheme:

1) Three pcs. subducts, two 1-½ in. and one 1 in. Subducts colors are orange, green, and white.

2) Four pcs. of 1 in. subducts, the subducts colors are orange, green, white, and blue. It shall be used if NEMA-TC 8 PVC conduit and HDPE pipes, solid wall. Refer to SAES-T-911 for more details.
3) HDPE pipes (corrugated wall): Five pcs. subducts, the built-in subducts colors are orange, green, white, blue, and black shall be used. Refer to SAES-T-911 for more details.
4) HDPE pipes (solid wall): Three pcs. subduct, the built-in subducts colors are orange, green, and white. Refer to SAES-T-911 for more details.

5.2.3.5 Subduct Construction Drawings

Construction drawings shall include placement information including but not limited to the following requirements:

1) Duct assignment, to be reviewed by IT Engineering Department.
2) Length of the subduct to be left at each cable feed maintenance hole (minimum length of subduct sufficient to reach the opposite wall of the maintenance hole; plus at least 1 meter at maintenance holes where cable reels will be positioned for installation to act as a cable pulling guide).
3) Construction note specifying a 380 mm minimum subduct bending radius during installation
4) Possible problem areas (e.g., severe bends, dips, conduit transpositions, etc.
5) A subduct section numbering scheme, if the subduct is ordered to cut lengths.
6) Subduct racking position (e.g., cable rack position, on or under the cable racks, on walls, ceiling, etc.). Allow sufficient lengths of subduct for racking in intermediate maintenance holes. Subduct must be installed so as not to block conduits or obstruct future cable placement.
7) The number of conduits required in a proposed conduit system addition or extension depends on the number of cables necessary to provide for the installed service, and its expected of 20% growth of spare subduct plus one spare conduit for maintenance and repair purposes for a non-sharing duct bank. Cables required for growth may include facilities necessary to cutover and relieve an existing cable that is at maximum capacity.
8) In a situation when a duct bank is shared between Information Technology (IT) applications and non-Information Technology applications (fiber optics for Process control systems, Power system automation, Industrial Security, In-plant paging system, Video

surveillance System, a special consideration is needed to count for future needs. A minimum of 20% for IT and 20% for non-IT for future needs of spare sub-ducts plus one spare conduit for maintenance and repair purposes. The one spare conduit shall not be calculated as a future growth requirement.

9) The number of conduits shall be specified in the Project Proposal. Refer to SAES-T-911 for additional requirements to comply.

5.2.3.6 Subduct Cutting and Splicing

1) Subduct shall not be cut or spliced for a minimum of 24 hours after placement to allow for subduct shrinkage. Subduct splices shall only be made inside the maintenance hole between the cable vertical racks. Threaded, self-tapping type subduct couplers shall be used to splice subducts.
2) For HDPE pipes with corrugated wall and built-in subduct, the main duct and subduct shall be installed without cut or connectors in the midspan from maintenance hole to maintenance hole, pedestal to pedestal or a combination.

5.2.3.7 Conduit Design

All conduit systems shall be designed as requires for fiber and copper cables, refer to SAES-T-911 standard for more details.

5.2.4 Underground Cable Engineering

5.2.4.1 Subduct Requirements

When a design calls for installing fiber optic cable in an underground conduit system, the fiber optic cable shall be installed inside a subduct.

1) For PVC conduit: If the conduit system does not have existing subducts in one of its ducts, then a 4 pcs. of 1-inches subducts shall be placed in one of the existing ducts and one subduct shall be left vacant for operations and maintenance purposes. In addition, this is also applicable to HDPE pipes with solid wall type.
2) Refer to SAES-T-911 for the 20% future growth requirements and plus a one spare duct for the maintenance and repair purposes.

5.2.4.2 Underground Cable Design and Construction Drawings

Engineering design and construction drawings for underground fiber optic cables shall show the following information:

1) Maintenance holes
2) Maintenance hole diagrams illustrating cable, rack, and splicing locations of all facilities
3) Conduit wall-to-wall (inside surface of the first maintenance hole wall to the inside surface of the second maintenance hole wall) measurements
4) Radius and length of curve for all curves, sweeps, and bends
5) Dips, etc., that would affect cable pulls
6) Locations for setting up the cable reel
7) Minimum bending radius of the cables to be installed
8) Maximum pulling tension of cables
9) Reel lengths in meters
10) Warning and cable identification tags or markers required in each maintenance hole
11) Bonding and grounding systems
12) Utility pipes, hydrocarbon pipes, railroads, and road crossings properly named with station numbers.

5.2.4.3 Underground Cable Lengths

Fiber optic cable design and construction lengths shall allow sufficient length for:

1) Racking in pull-through maintenance holes.
2) Slack at splice points (minimum of 3 meters plus the requirement of Section 5.2.5.7 below).
3) Central office and other building cabling.
4) Slack for future splice or drop points (minimum of 3 meters plus the requirement of Section 5.2.5.7 below

5.2.4.4 Cable Splices

To keep future new cable openings to a minimum, underground fiber optic cable splices shall be located at points where future branch splices will be required, in so far as it is practical to do so. Underground fiber optic cables shall not be cut for splicing convenience.

CAUTION:
All fusion splices shall be made outside maintenance holes and at least 3 meters away from the maintenance hole opening. Mechanical splice of fiber optic cable is not permitted.

5.2.4.5 Field Survey

A field survey shall be made of all proposed fiber optic cable installation routes to determine if there are traffic/parking problems or other unsafe conditions at proposed splice and cable pulling locations. Check each maintenance hole, through which the cable will pass, to confirm that adequate space is available for pulling, racking and splicing the cable. Determine if other conditions exist in the field, which would require change of the tentative design. Cable reel setup locations shall provide adequate space for:

- Cable trailers
- Trucks
- "Figure 8's" of cable for split reel pulling, when required

The "figure-eight" configuration should be used to prevent kinking and twisting when the cable must be unreeled or back fed. The "figure-eight" should be approximately 4.5 meters in length. Each loop should be approximately 1.5 meters to 2.5 meters in diameter.

5.2.4.6 Cable Ordered by Cut-Length

When cable is to be ordered by reel cut length, the reel cut length should be a total of the following:

1) All wall-to-wall lengths.
2) The amount for racking in all pull-through maintenance holes.
3) The slack loop length at splice points, typically 15 meters on each end.
4) The lap required for splicing the ends of the reel, typically 3 meters for each end of the reel.
5) Central office and other building or termination point cabling.

5.2.4.7 Cable Placement Tools

The following tools shall be used when placing underground fiber optic cables:

1) A pulling swivel (maximum ⅞-inch diameter).
2) A tension monitoring device, such as:
   a) A dynamometer (1,000 pounds) or equivalent
   b) A mechanical puller equipped with "built-in" monitoring capability or equivalent

Commentary Notes:

i. Before starting cable pull, test pulling devices equipped with pre-set load cut-off devices to ensure they are operating properly.

ii. A running line dynamometer or equivalent shall be used to monitor the pulling tension applied to the cable during the entire cable pulling operation.

iii. The dynamometer shall be calibrated prior to start of the cable pulling operation and at the intervals specified by the manufacturer.

iv. An observer shall be stationed to observe the dynamometer during the pulling operation to make sure the set limit is not violated.

3) A ⅜-inch line for dynamometer calibration [15 to 23 meters]
4) Large cable wheel(s) having a minimum radius of 20 times the cable diameter

5.2.4.8 Underground Cables shall be Non-metallic

Underground OSP fiber optic cables shall be all dielectric (non-metallic).

5.2.4.9 Cable Placement Coordination

Before starting underground placing work, all personnel shall know the communication signals that will be used.

Personnel shall be stationed at:
1) The reel location during pulling activities to maintain proper reel rotation
2) Pull-through maintenance holes to:
   a) Alert the pulling personnel in the event of a mishap.
   b) Monitor the cable during the pulling process.
   c) Help with cable lubricating, as required.
   d) Help guide the cable into the duct on the opposite
   e) side of the maintenance hole if the subduct is
   f) non-continuous through the maintenance hole.

5.2.4.10 Set-up for Cable Pull

At the maintenance hole where the cable reel is set up for pulling-in, bring the end of the subduct out of the maintenance hole (splice on additional subduct if the existing duct is not long enough) and set it in position for feeding the cables.

Place a generous amount of lubricant in the subduct before and during the pulling operation. See the manufacturer's recommendations for

proper lubricant application. Always use manufacturers recommended lubricants. Do not use petroleum-based lubricants.

5.2.4.11 Cable Racking in Maintenance Holes

Fiber optic cables shall be racked in maintenance holes so as to:

- Lessen the possibility of accidental damage
- Separate fiber optic cable/subduct from other cables
- Permit subducts to rack on the same brackets or hooks at the same level, when subducts are continuous pieces
- Maintain minimum bending radius of ten times the cable diameter
- Secure the subduct to the maintenance hole rack with cable support ribbon or tie wraps

5.2.4.12 Subduct Percent Fill

To allow sufficient space for pulling grips or pulling eyes, etc., in general, the cross-sectional area of the cable should not exceed 53% of the inside cross-sectional area of the subduct for one cable, 30% for two cables, and 40% for three cables. Refer to ANSI/EIA/TIA-569-E for more details on cable capacity for conduits having cross sectional areas ranging from 2 cm^2 to 82 cm^2.

5.2.4.13 Safety Requirements

Applicable standard for all underground fiber optic cable installations shall comply with the safety requirements stated in SAES-T-911, SAES-T-928, Saudi Aramco Construction Safety Manual, Saudi Aramco Safety Management System (SMS) and Company applicable safety practices.

5.2.5 Direct Buried Cable Engineering

5.2.5.1 Placement Methods and Safety Requirements

The plowing-in method is the preferred method for burying optical fiber cables. Before plowing in fiber optic cables, it is recommended that the route be pre-ripped so that obstacles can be identified and removed or necessary precautions taken prior to the actual placement of the cable. The placing operation precautions during installation, backfilling, etc., shall be in accordance with SAES-T-928. During the placing operation, buried fiber optic cables shall not be cut for convenience.

5.2.5.2 Engineering Design

The engineering design shall be well planned such that:

1) The designated number of splice points shall not be increased during the construction stage.
2) Splice points are spaced to coincide with designated reel lengths.
3) Suitable splice locations are selected.
4) Splice locations are accessible.
5) The number of splice points are kept to a minimum.
6) Buried splices and isolated conduit ends are identified with Electronic Marking System (EMS) markers. The EMS shall be tested in accordance with manufacturer's instruction.
7) Splice locations are safe for personnel

5.2.5.3 Splice Placement

Only direct buried type splice closures shall be used in direct buried cable systems. The fiber optic cable “out-of-pit” cable slack shall be coiled and housed inside the splice pit.

Splice and other access points shall be located so as to avoid areas that:

1) Are vulnerable to damage by vehicular traffic or other means.
2) Are subject to flooding or standing water.
3) Have a number of obstacles (which would tend to increase the need to cut and splice the fiber optic cable), such as:
   - Railroads, Highways, Pipelines, Driveways, & Parking lots

5.2.5.5 Cable Direct Burial and Conduit System Methods

1) For direct buried Fiber optic cable, it shall comply with the SAES-T-928 standard.
2) For conduit system of fiber optic cable, it shall comply with SAES-T-911 standard.

5.2.5.6 Marker Tape or Warning Tape

Marker tape/Warning tape requirements shall comply with SAES-T-911 standard (conduit system) and SAES-T-928 (direct buried installation).

Commentary Note:

The orange marker tape shall be installed in a flat level when placed above the all open trench direct buried cables. However, for the plowing method it must be flat, if possible.

5.2.5.7 Splices to be made inside Splicer's Vehicle

At all buried splice locations, sufficient additional cable length (slack) shall be left to reach from the splice enclosure (or splice pit) to the inside of a cable splicer's vehicle or other facility that maintains a suitable environment for splicing fiber optic cable.

5.2.5.8 Grounding Metallic Members

Refer to SAES-T-795 and SAES-P-111 standards for more detailed requirements to comply.

5.2.5.9 Minimum Cover Requirements

Direct buried fiber optic cables shall be placed with a minimum cover of:

1) Shall be at 1,200 mm, when placed with no additional protection.
2) Shall be at 760 mm (traffic area) and 610 mm (non-traffic area), when placed inside a conduit system, refer to SAES-T-911.
3) Shall be at 250 mm to 760 mm, in rock areas, see Standard Drawing AA-036748). In addition, fiber optic cables shall not be placed with less than 250 mm cover in any situation.
4) For concrete encased conduit (refer to SAES-T-911).
5) For non-metallic material, HDPE pipes (as mechanical protection), solid wall or corrugated wall types, shall comply with SAES-T-911 standard.
6) For Fiber optic cables installation in a joint trench with the pipeline, it shall comply with SAES-T-928 and SAES-L-450 standards.

5.2.5.10 Cable Quantities

When ordering fiber optic cables, include:

1) The measurements between splice points.
2) Splicing overlap, typically 3 meters at each end.
3) The amount of cable required for “out-of-pit” splicing -- typically 15 meters at each end.

5.2.6 Aerial Cable Engineering

Aerial fiber optic cable construction shall only be approved through waiver.

Commentary Note:

(1) Aerial fiber optic cable system engineering designs and installations shall comply with BISCI OSPRM requirements.

(2) Support Strand or Messenger shall comply with BISCI OSPRM requirements.

(3) All dielectric (non-metallic) fiber optic cables shall be used in all aerial installations.

(4) Allowance for Expansion and Contraction: approximately 150 mm of excess fiber optic cable(s) slack shall be left at every pole for normal expansion and contraction.

(5) Grounding Metallic Members in Aerial Cables shall comply with BISCI OSPRM requirements.

5.2.7 Splicing Fiber Optic Cables

Refer to SAES-T-632, for Splicing fiber optics cable requirements.

5.2.8 Link Loss Budget Calculation Requirements

5.2.8.1 During the design stage a link loss budget shall be prepared and included with the project proposal and design packages.

The link loss budget calculation table shall be included in the design phase as follows, see below table.

1) Total fiber attenuation (loss).
2) Splice loss (including pigtail splices, if pigtails are used).
3) Connector loss.
4) Wave Division Multiplex (WDM) losses, if used.
5) A margin for light source aging as per manufacturer's specification.
6) If the system manufacturer does not specify the operating margin, use value of link loss margin of 3 dB (Laser) and 2 dB (LED) minimum for restoration splices.
7) Total no. of splices and total no. of connectors.

5.2.8.2 The calculated dB loss cannot exceed the operating range of the terminal equipment that will be installed. Measured end-to-end loss should measure less than the calculated loss. Fibers that measure a higher loss than the link loss budget will not be accepted. All loss

measurements shall be documented and distributed in accordance with the standard.

Typical Transmission Data Link Table (Link Loss Budget Calculation)

FOC ID	Fiber Optic Section		Fiber Length (m)	Fiber Loss (dB)		Connector Loss (dB) 0.5 dB / connector	No. of connectors	Splice Loss (dB) 0.1 dB / splice	No. of splices	Computed Fiber Loss (dB)	
	From	To		TBD	TBD					TBD	TBD

Note:

(1) TBD: It shall be defined during the project phase.

(2) Connector loss (0.5 dB): refer to section 7.1 Acceptance Testing Requirements

(3) Splice loss (0.1 dB): refer to section 7.1 Acceptance Testing Requirements

(4) Link Loss Margin: 3 dB for Laser and 2 dB for LED

(5) FO Cable Specification shall be defined:
- Cable Types and specification
- No. of Strand/s
- Operational Wavelength
- Attenuations

5.2.9 Spare Fiber Strands in a Fiber Optic Cable

During the design stage of new or upgraded of the fiber optic cables systems, spare fiber strands shall be reserved between any two end points of a cable system, including branch links. The following shall be required:

1) Design and allocation of the spare strands of fiber optic cable system shall be reviewed by IT Engineering Department. The design shall be included in the cable design package.

2) Spare fiber strands shall not be used unless reviewed by the stakeholders (IT Engineering Department, AREA-IT, Plant Facilities and etc.).
3) Spare fiber strands shall only be used on a temporary basis for emergency service restoration, maintenance, upgrade, and testing activities.
4) Spare fiber strands shall be spliced and terminated at the Fiber Distribution Panel (FDP), and marked as spares.
5) As a minimum, two (2) fiber strands shall be reserved on fiber cables containing twenty-four (24) fibers or less, and a four (4) fiber strands on fiber cables containing thirty-six (36) fibers strand and above.

5.2.10 Fiber Optic Cable Sizing

The number of strands for fiber optic cable shall be sized to meet the minimum requirements, and it shall be sized with at least 50% of additional strands, aside from the above initial strand reservation requirements .

1) For Inter-building application, a 24-fiber strand is required. This is applicable between non-main or non-major TER's, and this include temporary buildings or structures.
2) For Inter (campus)-building applications, a 48-fiber strand is required. This is applicable between main or major TER's (different buildings within the campus area or premises).
3) For Inter-Area backbone link, a 96-fiber strand is required. This is applicable between main or major TER's or DCO (different buildings not within the campus area or premises).

5.3 Inter and Intra Building Consideration

This section describes the fiber optic cables for inter-building (campus) and intra-building (includes building distribution system - riser and plenum applications).

5.3.1 The following fiber cable (FOC) shall be either of the followings;

SINGLE-MODE OPTICAL FIBER (Dispersion-Shifted or Non-Zero Dispersion-Shifted) - (In accordance with applicable ITU-T-G.652 /ITU-T-G.653/ ITU-T-G.655)

OR

MULTI-MODE Optical Fiber, 62.5 µm (core)/125 µm (cladding), GRADED-INDEX OPTICAL WAVEGUIDE FIBER (In accordance with applicable EIA/TIA-455 series)

OR

MULTI-MODE Optical Fiber, 50 µm (core)/125 µm (cladding),GRADED-INDEX OPTICAL WAVEGUIDE FIBER (In accordance with the latest version of ITU-T G.651)

Commentary Note:

As per Saudi Aramco Information Technology best practices, it is highly recommended to use:

1) *Single Mode OS1 Fiber (ITU-T G.652.D) for Inter-building (campus) or inter-area backbone connectivity.*
2) *For higher speeds and longer distances, single mode fiber optic cables shall be used.*
3) *The multimode fiber optic cable parameters as specified in this standard are applicable for transmission speed up to 155 megabits per second (Mbps) for distances up to 2 km (OM1), transmission speed up to 1 Gigabit per second (Gbps) for distances up to 550 m (OM2) or transmission speed up to 10 Gigabit per second (Gbps) for distances up to 300 m (OM3) only. Multimode fiber cable usage shall be in accord with IT Engineering Department.*
4) *OM3 and OM4 (50125) laser optimized fiber and/or Single Mode- OS1 Fiber (ITU-T G.652.D) for intra-building backbone.*

All fiber optic cables installed as wiring inside buildings shall be a tight-buffer (designed for indoor use), Optical Fiber Non-conductive Plenum (OFNP) or Optical Fiber Non-conductive Riser (OFNR) type, moisture barrier and shall be listed as being suitable for the purpose, listed as being resistant to spread of fire in accordance with the NEC Article 770 Section 770-26, installed in accordance with Section 770-110, and marked in accordance with Table 770-179.

5.3.2 For Single-mode and Multi-mode fiber optic cable specifications, it shall comply in accordance with the 18-SAMSS-625.

5.4 Fiber Optic Connectors

Fiber optic connectors shall meet the transmission criteria in accordance with the BICSI TDMM or BISCI OSPDRM and EIA/TIA-568.3-D. The most common fiber optic interfaces are as follows:

- LC (Latching Connector): LC-style connectors are about half the size of SC style duplex connectors, providing significantly greater density.

- SC (Subscriber Connector): It is commonly used in network equipment transceivers, and recognized by cabling standards for use as backbone and horizontal connectivity.
- ST (Straight Tip): a connector having a key that prevents rotation of the ceramic ferrule and a bayonet lock similar to a BNC shell.

Commentary Note:

1) All fiber optic connectors shall comply with EIA/TIA-568.3-D. Only the ST and SC type connectors (as specified in IEC 60874-14 and IEC 60874-10 respectively) shall be used for terminate fiber optic cable.

2) As per Saudi Aramco Information Technology best practice, the preferred choice is SC type connector.

5.5 Temporary Buildings or Structures Consideration

The re-use of fiber optic cables and OSP underground infrastructure resources for future needs, the following requirements listed below shall be followed.

5.5.1 The temporary buildings or structure shall be designed to have a telecommunication underground outside plant (OSP) spaces (e.g. pedestal, maintenance hole, Optiped) outside the building.

Commentary Note:

As per Saudi Aramco IT best practice, it is highly recommended:

1) The used of the UPC 1248 pedestal or larger size is preferred, and it shall be located adjacent to the building prior to the cable entry.

2) The used of maintenance hole and Optiped shall be reviewed by the stakeholders, and the location shall be determined during the detailed design stage. If Optiped is used, it shall be buried at a minimum of 300 mm below ground (measured from the Optiped lid), and a marker post is required.

5.5.2 During the building demolished, telecommunication outside plant (OSP) fiber optic cables shall be placed in the OSP spaces for safekeeping and for future utilization.

5.5.3 All OSP fiber optic cable strand shall be terminated in a secure OSP rated splice closure.

6 Installation

The installation of all Fiber optic cables for OSP (Outside Plant) and Inter/Intra-building applications covered by this standard shall comply with the applicable SAES-T standards, SAES-O-201 (Application of Security Directives), BICSI TDMM and BICSI OSPDRM - Building Industry Consulting Service International (BICSI), and National Electrical Code (NEC).

7 Testing and Inspection

End-to-end testing shall be carried out on all fiber optic cables (defined as the span of fiber from the transmitter to the receiver) to document the overall optical loss.

7.1 Acceptance Testing Requirements

Acceptance testing requirements for fiber optic cables shall comply the requirements stated in the table below, and five (5) basic tests for fiber optic cables as follows, see Table 1.

Table 1- Acceptance Testing Requirements

Test	Requirement
1) End-to-End Loss **2)** *(typically conducted after completion of installation and splicing, also before installation of terminal equipment's using OTDR).*	100% of fibers in both directions, and 100% of fiber splices and connections; (individual splice loss shall not exceed the following limits; The maximum attenuation of each fiber within a cable, when normalized to a length of 1 km: a) At wavelength = 1,300 nm, shall be 0.5 dB/km or less, and b) At wavelength = 1,550 nm, shall be 0.3 dB/km or less. c) Individual splice insertion loss shall be .05 dB average link splice loss with no single splice loss above 0.1 dB for fusion splices, and 0.1 dB average link splice loss with no single splice loss. d) Connectors shall have insertion losses of 0.5 dB or less).
3) On-reel	Acceptance tests shall be performed on the cable to ensure materials quality prior to installation using OTDR.
4) Measuring Power (Power Meter Test)	This measurement is the basis for loss measurements as well as the power from a source or presented at a receiver.
5) Link Test *Commentary Note:* *This type of testing is applicable for long haul networks to ensure proper link performance and typically for back bone fiber.*	Each link shall be tested for zero transmission error performance at the highest bit rate expected to be carried over the cable section. This test is to be performed with a transmission analyzer**.**
6) Chromatic Dispersion Coefficient *Commentary Note:* *This type of testing is applicable for long haul networks to ensure proper link*	**Fiber Type** **Wavelength Range (nm)** **Maximum Chromatic Dispersion Coefficient**

Test	Requirement
performance and typically for back bone fiber, this include offshore FO cables.	**[ps/(nm.km]** **Zero-Dispersion** 1288-1339 3.5 1271-1360 5.3 **Dispersion Shifted** 1525-1575 3.5 **Non-Zero Dispersion Shifted** 1530-1565 6.0
7) Polarization Mode Dispersion Coefficient *Commentary Note:* *This type of testing is applicable for long haul networks to ensure proper link performance. This typically apply to very high bite rates of 40 Gbit/s and above, this include offshore FO cable.*	PMD coefficient shall be below 0.5 ps/√km

7.2 Splice acceptance tests (individual splice insertion losses) shall be .05 dB average link splice loss with no single splice loss above 0.1 dB for fusion splices, and a 0.1 dB average link splice loss with no single splice loss; connectors shall have insertion losses of .5 dB or less).

7.3 On-reel acceptance tests shall be performed on the cable to confirm the manufacturer's tests before the placing operation begins.

7.4 Each link shall be tested for zero transmission error performance at the highest bit rate expected to be carried over the cable section. This test is to be performed with a transmission analyzer.

7.5 After each fiber is tested in one direction (Office A to Office B or host-remote link), loss measurements shall be documented on the Optical Fiber Cable Acceptance Test Record (Exhibit 1). Upon test completion, transmitter and receiver shall be reversed, and test shall be repeated in the other direction (Office B to Office A or host-remote link).

Commentary Note:

The transmitter is located in Office B, the receiver is located in Office A.

7.6 Optical fiber cable acceptance test shall be recorded on the Optical Fiber Cable Acceptance Test Record (Exhibit 1) according to Table 2 instructions.

Table 2 – Optical Fiber Cable Acceptance Test Record Instructions

In Term	Specify
A	End-to-end test or Splice Loss Data
B	The assigned span number designation
C	The assigned cable/trunk number
D	The assigned cable count
E	The type of fiber, i.e., multimode or single mode
F	The designed wavelength, e.g., 1310 or 1550 nm
G	The calculated allowable loss
H	Central Office A
I	Central Office B
J	Fiber color, Buffer tube color

7.7 As-built Drawings

Red-line drawings shall be updated daily by field installation forces and shall be reflected in the final preparation of the As-Built drawings the acceptance tests results shall be provided and be submitted to Saudi Aramco IT Engineering Department and/or Area IT before Mechanical Completion Certificate (MCC).

7.8 Inspection Department Notification

The Saudi Aramco Inspection Department shall be notified two working days prior to beginning any construction 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.

7.9 Design Variations

Copies of all approved design variations document shall ready be available to the any representative, i.e., Inspection Department, IT Engineering Dept. and AREA-IT.

Document History

25 May 2014	Revised the Next Planned Update, reaffirmed the content of the document, and reissued as major revision.
3 August 2015	Editorial revision to paragraph 4.9, fifth (5th) bullet.
18 October 2016	Major revision as part of Communications Standards Committee optimization initiative to be in alignment with international standards and its functionality. It also provides better clarification and understanding to the standard's users.
22 January 2018	Consolidation of SAES-T-634 to this standard, adding requirements address to testing of fiber optic cables.
08 March 2021	Major revision: Adoption of non-metallic materials (HDPE pipes) for underground infrastructure, Installation of FO cables using cable trays and conduits for above ground installation.

Exhibit 1 – Optical Fiber Cable Acceptance Test Record

OPTICAL FIBER CABLE ACCEPTANCE TEST RECORDS

Page _____ of _____

Area Location: _____ BI/ER #:_____ Date: _____

Check One Box: *(A)* ☐ A. End-to-End Fiber Test ☐ B. Splice Loss Data

SPAN NUMBER	CABLE NUMBER	CABLE COUNT
_____ *(B)*	_____ *(C)*	_____ *(D)*

FIBER TYPE:	WAVELENGTH (nm)	MAX. ALLOWABLE LOSS: (dB)
(E) ☐ A. Single Mode ☐ B. Multimode _____	_____ *(F)*	_____ *(G)*

A	OFFICE A	OPERATOR'S NAME	OFFICE B	OPERATOR'S NAME
	_____ *(H)*	_____	_____ *(I)*	_____

B	SPLICE LOCATION	TYPE TEST SET USED	DISTANCE TO SPLICE
	_____ TYPE OF TEST EQPT. USED _____	_____ TEST SET LOCATION _____	_____ TEST SET OPERATOR'S NAME: _____

FIBER NO.	COLOR (J)	FINAL MEASURED LOSS (dB)		CHROMATIC DISPERSION COEFFICIENT (CD) ps/(nm·km)		POLARIZATION MODE DISPERSION COEFFICIENT (PMD) ps/√km	FIBER NO.	COLOR (J)	FINAL MEASURED LOSS (dB)		CHROMATIC DISPERSION COEFFICIENT (CD) ps/(nm·km)		POLARIZATION MODE DISPERSION COEFFICIENT (PMD) ps/√km
	BUFFER	FIBER	A - B	B - A				BUFFER	FIBER	A - B	B - A		
1							19						
2							20						
3							21						
4							22						
5							23						
6							24						
7							25						
8							26						
9							27						
10							28						
11							29						
12							30						
13							31						
14							32						
15							33						
16							34						
17							35						
18							36						

Remarks:

_____

_____

This form to be completed by Fiber Test Operator at receiving location