Engineering Standard

SAES-Z-020 05 October 2020

Design and Installation of Fiber Optic Cable Systems for Process Control Networks

Document Responsibility: Plants Networks Standards Committee

Contents

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Summary of Changes

Paragraph Number		Change Type (Addition, Modification, Deletion)	Technical Change(s)
Previous Revision (1 January 2018)	Current Revision (5 October 2020)		
3	3	New	Update references list (adding new, deleting obsolete ones)
5.7 (D)	5.7 (D)	Modification	Modified to reference SAES-T-624 and SAES-T-916 for optical connectors
6.2	6.2	Modification	Underground duct systems will be installed based on SAES-T-911, which allow the use of HDPE in some cases. All other scattered requirements in section 6.2 were deleted.
6.3	6.3	Modification	Modified for clarity
-	6.4 (3)	New	Add one statement about duct sealant in compliance with the Communications standards requirements (newly issued SAES-T-911)
6.5 (6)	6.5 (6)	Modification	To ensure adequate cable slack during fiber cable installation (in compliance with SAES-T-632)
6.9	6.9	Modification	Update reference
6.10 (2 and 3)	6.10 (2 and 3)	Modification	Modified for clarity and in compliance with SAES-T-916
7.2	7.2	Modification	Delete obsolete reference
8 (1)	8 (1)	Modification	Delete commentary note for clarity. The requirements for splicing were already updated in section 6.7.

1 Scope

This standard covers minimum mandatory requirements governing the design and installation of fiber optic cable infrastructure systems inside Saudi Aramco process plants for process control systems applications only. For telecommunications applications, refer to the applicable SAES-T-series standards. All process control fiber optic cable infrastructure systems inside Saudi Aramco process plants are owned by the plants.

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

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall apply 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-B-008	*Restrictions to Use of Cellars, Pits, and Trenches*
SAES-B-068	*Electrical Area Classifications*
SAES-J-902	*Electrical Systems for Instrumentation*
SAES-P-104	*Wiring Methods and Materials*
SAES-T-624	*Telecommunications: Fiber Optic Cables for Outside Plant (OSP) and Inter/Intra Building Applications*
SAES-T-632	*Telecommunications: Splicing Copper Cables, Fiber Optic Cables, and Types of Splice Closure*
SAES-T-911	*Telecommunication Conduit System Design*
SAES-T-916	*Telecommunications- Building Cable Systems, Pathways and Spaces*
SAES-Z-001	*Process Control System*

SAES-Z-004 *Supervisory Control and Data Acquisition (SCADA) System*

Saudi Aramco Materials System Specifications

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

3.2 Industry Codes and Standards

Building Industry Consulting Service International (BICSI)

TDMM *Telecommunications Distribution Methods Manual*

OSPDRM *Outside Plant Design Reference Manual*

International Society of Automation (ISA)

ANSI/ISA-TR12.21.01 *Use of Fiber Optic Systems in Class I Hazardous (Classified) Locations*

National Fire Protection Association

NFPA 70 *National Electrical Code (NEC)*

Telecommunications Industry Association (TIA)

EIA/TIA-568 SET *Commercial Building Telecommunication Cabling Standard*

4 Terms and 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.

Fiber Optic Cable: A cable that contains individual glass fibers, designed for the transmission of digital information, using light pulses.

Fiber Node: A location that contains the passive and/or active fiber optic components to interconnect the fiber feeder with the distribution point.

Fiber Hub: A location with a single feeder cable from a fiber node and multiple fiber cables to outlying buildings. Fiber hubs are typically used if individual cables from the node to the buildings are either cost prohibitive or impractical.

Hazardous (Classified) Location: A location in which fire or explosion hazards may exist due to an explosive atmosphere of flammable gases or vapors, flammable liquids, combustible dusts, or easily ignitable fibers.

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

Minimum Bend Radius: The minimum radius a fiber may be bent before optical losses are induced.

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

Process Control Network (PCN): A proprietary process control networks provided as part of a vendor's standard process control system.

SCADA: Supervisory Control and Data Acquisition

Splicing: A permanent junction between optical fibers may be thermally fused or mechanically applied.

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.

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

5 Design

5.1 System Layout

a) Layout of a fiber optic cable system shall comply with SAES-Z-001.

b) All fiber nodes within the plant shall provide five nines (99.999%) availability.

c) Composite cable of power and fiber optic shall not be used.

d) Aerial fiber optic cables shall not be used.

e) Fiber optic 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) or BICSI Outside Plant (OSP) Designer.

All related design drawings must be stamped by the RCDD before the package can be issued for Construction (IFC).

5.2 Cable Routing

a) Multiple fiber optic cables between two locations shall be diversely routed to provide additional reliability and survivability.

Commentary Note:

For specific system cable route redundancy requirement, refer to the applicable standard (i.e., DCS per SAES-Z-001, for SCADA per SAES-Z-004, and so on).

b) There shall not be more than one fiber hub between a destination location and its originating node.

c) Multimode fiber cable runs shall not exceed 2 kilometers between the node and the final termination point.

5.3 Cable Sizing

a) Fiber cables shall be sized with at least 50% additional strands above the initial strand requirements. The following minimum strand count shall also be applied:

i) 24 strand count for cable run to a building or a facility that is not a node or hub.

ii) 12 strand count for cable run to small or temporary locations.

b) Spare fiber strands shall be spliced and terminated at the Fiber Distribution Panel (FDP), and marked as spares.

5.4 Documentation

As a part of each process control fiber optic cable infrastructure work order/project, detailed drawings and documents shall be prepared for each fiber optic cable system, showing the following information:

5.4.1 Fiber Cable Data

a) Cable manufacturer.

b) Cable size (number of fibers).

c) Cable type (filled or air core).

d) Cable make-up (dielectric/nonmetallic).

e) Type of fiber (multimode or single-mode).

f) Dispersion shifted or non-dispersion shifted.

g) Fiber packaging (e.g., single fiber/loose buffer; multiple fiber/loose buffer; tight buffer, channel/groove or ribbon type, and color code, etc.).

5.4.2 Design Drawing

a) Cable route drawing (single line drawings)

b) Cable schematic and detail drawings shall identify support transitions, cable installation method on each section, building entrances and congested areas.

c) Wiring closet floor plans and equipment rack layout shall identify cable routing inside the wiring closet and location of fiber distribution panels.

d) Equipment rack layout with distribution panels

5.5 Link Loss Budget Requirements

Link loss budget calculation shall be prepared and included with the project proposal and design packages. Refer to SAES-T-624 (Section 5.2.8).
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.

5.6 Optical Fiber and Cable Specifications

All plant fiber optic cables for instrumentations and process control networks installations shall be in accordance with 18-SAMSS-625.

5.7 Fiber Optic Cable Installation

A. Outdoor Cables

1. All 'Outdoor Fiber Optic Cable' shall be loose-tube buffered.

2. Cable shall be constructed of all dielectric materials. There shall be no metallic materials in the cable including the central strength member.

3. Cable construction shall be such that specified optical transmission properties are maintained when cable is installed and operated under manufacturer's specifications for loading, bend radius, and temperature.

4. For an individual link, same type of cable shall be used to ensure same performance characteristics and to ensure compatibility of the geometrical parameters, attenuation, and dispersion of the fiber.

5. All fiber optic outdoor cables shall be designed for a minimum temperature range of -5°C to 70°C at operating, placement, and

storage conditions.

B. Fiber Jumpers

1. Fiber jumpers for multi-mode fiber shall be orange and fiber jumpers for singlemode fiber shall be yellow.

2. Fiber jumpers for routing inside cabinets shall be factory-built with each strand within its own subunit cable. Dual or Zipcord fiber jumpers are acceptable.

3. Jumper cables shall be listed as being suitable for the intended purpose according to NEC classifications in Article 770-50.

C. Fiber Distribution Patch Panel (FDP)

1. Fiber Distribution Panels (FDPs) shall be designed so that the fiber optic cable enters from the rear of the FDP.

2. FDPs shall be equipped with a mechanism to relieve strain on the cable.

3. FDPs shall be designed so that, under normal installation, fibers are not subjected to bends radii less than the minimum recommended by the manufacturer.

4. FDPs shall be designed to provide access only to individual pairs of fibers during installation of fiber jumpers or maintenance.

5. FDPs shall have a means of protecting the individual fibers. Under normal access, the FDP shall not allow contact with the fiber cable or individual fibers terminated in the FDP.

6. FDPs shall be designed with storage for excess slack of fiber jumpers in order to prevent multiple jumpers from becoming tangled with each other and exceeding their minimum bends radii.

7. FDPs shall have an isolated partition to store splice trays and/or function breakout transition points.

8. FDPs shall have a protective cover over its front. Cover shall be able to be modified so that a locking device can be added in the future.

9. Fiber jumpers shall be accessible only from the front of the FDP.

D. Optical Connectors

1. All fiber optic connectors shall comply with EIA/TIA-568. You may refer to SAES-T-624 and SAES-T-916 for additional information.

2. Each plant shall standardize on one type of connectors, as applicable.

Commentary Note:

For methods and guidelines on the proper installation and connection of optical fiber cabling, refer to EIA/TIA-568.

6 Installation

6.1 General

1. Direct burial of fiber optic cables is prohibited.
2. Conduit and/or cable tray systems shall be used for outdoor and/or indoor fiber optic cable installation. For details see sections 6.2 and 6.3 respectively.
3. Data links fiber optic cables, shall be specified and installed per system manufacturers' recommendations.
4. When redundant data links are provided, the primary cable shall follow a different route from the back up cable.
5. Fiber optic cable installation may use existing cable pathway (cable tray, and conduit system) provided that the existing pathway comply with this standard.

6.2 Underground Conduit Systems

1. The primary fiber optic cable route shall be based on underground conduit system.
2. The design and installation requirements of underground conduit system shall follow SAES-T-911. This shall iclude marker posts and warning signs and other related design and intallation requirements of underground conducit systems.
3. The total number of conduits shall be designed to accommodate immediate and foreseeable future growth requirements. In all cases, this shall be at least 20% of the total number of conduits in addition to one additional spare conduit planned for maintenance and repair purposes.
4. When duct bank is shared between PCS and non-PCS (like IT), special consideration is needed to count for future needs. The above 20 % future spare requirements shall be maintained in addition to the spare conduit for maintenance and repair.

5. Installation of Fiber Optic System in Class I locations shall comply with applicable standards (SAES-B-068 and NEC Article 501).

6.3 Cable Tray Systems

1. In case of using cable tray system as a secondary cable route, its design, specification and installation shall be in accordance with SAES-J-902, Electrical Systems for Instrumentation, Section 9.

2. Fiber Optic cables shall not be installed in cable trays sharing with high voltage transmission or distribution cables. High voltage cable is defined as cables that carry circuits operating at over 480 volts.

6.4 Transitions

1. Fiber Optic cables shall be adequately supported (i.e., conduit or cable tray) at transitions from one type of installation method to another and also at transitions from one cable tray to another.

2. Cables shall be adequately supported at transitions into equipment, cabinets, and patch panels.

3. Conduit Plugs and Seals

Water seals must be used to prevent moisture entering in conduits where ever the conduits and sub ducts are exposed.

All conduits between structures should be sealed to prevent intrusion of liquids and gases into the structure. The two part polyurethane duct sealant shall be used to seal conduit that passing through the classified or hazardous areas to prevent gases and other liquids from emerging out of the telecommunication conduit system and entering a maintenance hole or telecommunications facilities, also it must be listed as UL 94.

6.5 Cable Installations

Fiber optic cable installations for process control in hydrocarbon processing plants shall comply with SAES-P-104, Wiring Methods and Materials, Section 15.4 and as outlined in this standard. 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 the facility:

i. Is equipped with a cable grid only, and/or

ii. Does not have available existing cable troughs or race ways.

3. Optical fiber cables may be routed with other high frequency (CXR) 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. Management of cable slack/loop cable shall be in accordance with SAES-T-632 standard.

6.6 Cable Bending and Pulling Tension

Refer to SAES-T-624 for cable bending radius and pulling tension requirements.

6.7 Cable Splicing

Refer to SAES-T-632 for splicing and splice closures requirements.

6.8 Cable Protection

During cable short and long term storage and cable handling, the cable shall be protected against environmental hazardous material and conditions that may be detrimental to the cable; like petroleum, petroleum based products, thermal, other chemical, mechanical, electrical conditions, etc.

6.9 Buildings Entrances

Fiber Optic Cables entering in buildings, control rooms or other indoor facilities shall comply with SAES-T-916 standard.

In addition, cable entry into control buildings or similar buildings in hydrocarbon processing plants shall also comply with SAES-P-104, Wiring Methods and Materials.

6.10 Fire Protection requirement

1. All Fiber optic cables placed inside buildings, control rooms, offices, shall comply with the fire protection requirements in accordance with ANSI/NFPA 70, NEC Article 770.

2. Outdoor fiber optic cables (non-fire rated) shall not be run exposed for more than 15 m (50.0 ft) within a building. If more than 15.2 m (50.0 ft) of cable is required between the building entrance point and the cable termination point. A transition splice point from outside plant (OSP) non-fire rated to indoor fire rated cable shall be made to limit the exposed non-fire rated cable to 15 m or less., Refer to SAES-T-916 for additional requirements.

3. Wrapping the outdoor cable with fire-rated tape is not acceptable.

4. Conduit and cable sealing, wherever are required, shall be installed in accordance with NEC Article 505.16.

7 Testing and Inspection

7.1 End-to-end testing shall be carried out on all fiber optic cable facilities (defined as the span of fiber from the transmitter to the receiver) and the overall optical loss shall be documented.

7.2 Acceptance Testing Requirements

The fiber optic cables testing shall be conducted in accordance with SAES-T-624.

7.3 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.

8 Safety Requirements

Classified Area Considerations

1. Fusion splicing shall not be used in classified areas

2. The Use of Fiber Optic Systems in Class I Hazardous (Classified) Locations shall comply with ISA-TR12.21.01.

3. Fiber Optic cables that are routed on trays in classified areas shall be specified per ISA-TR12.21.01- and shall be marked on the outer jacket as suitable for tray application.

4. Fiber optic cable used in hazardous (classified) locations must meet the fire resistance and smoke producing requirements of NEC Section 770.53.

5. Fiber optic cable used in Class I locations must be sealed in accordance with the requirements specified in NEC Section 501.15 or 505.16, as appropriate.

6. SAES-B-068 shall be used for electrical classification of plant areas where flammable gases or vapors, or combustible dust may be present in the air in quantities sufficient to produce ignitable mixture.

7. SAES-B-008 governs restrictions for on-site below-grade trenches and other appurtenances where hazardous vapors may collect.

Revision Summary

5 October 5, 2020	Major revision
1 January 2018	Editorial revision to modify paragraphs 5.1 (c) and 5.1 (d).
30 August 2017	Major revision to align with the new changes as part of the Communications standards optimization.
18 September 2014	Editorial revision to transfer the ownership of this document from Process Control Standards Committee to be under the newly established Plants Networks Standards Committee.
16 April 2012	Revised the “Next Planned Update.” Reaffirmed the content of the document, and reissued with minor revision.