Engineering Standard

SAES-T-919 6 February 2018

Submarine Fiber Optic Cable Systems

Document Responsibility: Communications Standards Committee

Contents

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1 Scope

This standard defines the minimum mandatory requirements for engineering, design, and installation of repeaterless standalone or composite optical fiber/electrical submarine cable systems.

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 and Definitions

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 Procedures

SAEP-13	*Project Environmental Impact Assessments*
SAEP-302	*Waiver of a Mandatory Saudi Aramco Engineering Requirement*
SAEP-339	*Marine Dredging and Landfilling Approval and Permitting*

Saudi Aramco Engineering Standards

SAES-T-624	*Telecommunications Outside Plant - Fiber Optics*
SAES-P-104	*Wiring Methods and Materials*

Saudi Aramco Materials System Specifications

18-SAMSS-006	*Specifications of Standalone Submarine Fiber Optic Cable*
18-SAMSS-008	*Specifications of Fiber Optic Cable for Composite Submarine Cable*
15-SAMSS-503	*Submarine Power Cable 5 kV through 115 kV*
15-SAMSS-504	*Submarine Power Cable 69 kV through 230 kV*

Saudi Aramco Engineering Report

SAER-5711 *Submarine Pipeline Engineering Guidelines*

3.2 Industry Codes and Standards

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

ITU-T G.97x *Optical Fiber Submarine Cable Systems*

ITU-T G. Supplement 41 *Design guidelines for Optical Fiber Submarine Cable Systems*

3.3 Definitions

Beach Joint: The cable joint made between the optical fiber submarine cable and the optical fiber land cable.

Deep Water: Water depths exceeding the limit of shallow water.

Land Cable: Cable with suitable protection for installation in ducts or direct burying in the ground.

Lowest Astronomical Tide (LAT): the height of the water at the lowest possible theoretical tide.

Optical Fiber Submarine Cable System: A set of equipment designed to permit the interconnection of two or more terminal stations. The optical fiber submarine cable system is usually composed of terminal equipment [terminal transmission equipment, power feeding equipment, maintenance controller, etc.), and submersible equipment (cable, repeater(s), branching unit(s), etc.].

Optical Fiber Submarine Cable Network: A network which interconnects three or more terminal stations using a single optical fiber submarine cable system or an integrated system made of system portions supplied by different suppliers.

Repeaterless Submarine Cable: An underwater optical fiber cable designed for unrepeatered applications and suitable for shallow and deep water use. It should be extensively tested to show it can be installed and repaired in its natural or original place, even in the worst weather conditions, without any impairment of optical, electrical or mechanical performance or reliability. The term “repeaterless” is also known as “unrepeatered” or “non-repeatered”.

Repeatered Submarine Cable: An electrically powered underwater optical fiber cable, designed for repeatered applications, which includes intermediate active equipment such as Optical amplifiers and repeaters.

Route Survey: The activity performed prior to cable laying so as to select the cable route and cable protection (fish-bite protection, armor, burying).

Shallow Water: Water depths down to a given limit, corresponding to the depths of fishing activity, or more generally of marine activity, creating a risk of cable fault.

NOTE: The limit of shallow water is of the order of 7.5 m below Lowest Astronomical Tide (LAT).

Surf Zone: The area between the shoreline and the outermost breaking wave, which occurs when the water depth equals 130% of the 100-year maximum wave height.

4 Design Requirements

The International Telecommunication Union (ITU) ITU-T G.97x series in addition to ITU-T G Supplement 41 are hereby adopted as Saudi Aramco standard for submarine fiber optic cable with the following exceptions:

4.1 Submarine optical fiber systems shall be designed for repeaterless submarine optical fiber cables only. Repeatered submarine optical fiber cables shall not be considered.

4.2 Submarine fiber optic cable systems shall be designed in accordance with ITU-T G. Supplement 41 "Design Guidelines for Optical Fiber Submarine Cable Systems"

4.3 Submarine fiber optic cables shall be manufactured in accordance to Saudi Aramco Materials System Specification 18-SAMSS-006, "Specifications of Standalone Submarine Fiber Optic Cable". Optical fiber unit within composite power-fiber optic submarine cables shall be manufactured in accordance with Saudi Aramco Materials System Specification 18-SAMSS-008, "Specifications of Fiber Optic Cable for Composite Submarine Cable".

4.4 Composite power - fiber optic submarine cables shall be manufactured, designed, and installed in accordance with SAES-P-104, 15-SAMSS-503, and 15-SAMSS-504. Maintenance responsibility of composite power - fiber optic cables must be agreed on in writing by relevant Saudi Aramco departments

4.5 New submarine cables shall be manufactured as one piece without munufacturer joins or splices.

5 Installation

5.1 Cable Mechanical Performance

Submarine cables shall be handled with caution by cable ships during laying and repair operation to avoid any damages to the fibers. Cable pulling tensions and bending radii shall be monitored and maintained within the limits specified by the manufacturer. Submarine cable must be tested during the laying and at the end of laying process to ensure that no significant system degradation has been induced. Laying testing includes transmission and functional tests, and may include tests on redundant subassemblies.

5.2 Submarine Route Survey

5.2.1 Project Environmental Impact Assessments (EIA) shall be conducted, per SAEP-13, to identify any environmental issues at a very early in the project in order to consider project alternatives that would reduce or eliminate adverse impacts and resource conservation potential. The EIA should recommend appropriate, cost-effective measures, which will mitigate significant environmental impacts, and describe how implementation of these recommendations will be monitored during construction and operation.

5.2.2 Route survey shall be performed prior to cable laying to select the cable route and means of cable protection (lightweight protection, armor, burial or combination methods). The route survey shall be also determine and address the sea bottom environmental sensitivity and ecological integrity. Refer to Appendix I for all applicable surveys needed prior to the installation.

5.2.3 The route survey report should consists of sea depth profile, the sea bottom temperature and seasonal variations, the morphology and nature of the sea bottom, the position of existing cables and pipes, the cable fault history, fishing and mining activities, sea current, seismic activity, laws, etc.

Commentary Note:

Cable route study should normally be carried out prior to the start of a route survey to determine all environmental, political, economic and practical aspects related to the route. Discussions should be held with local authorities and fishing bodies for this purpose, together with inspection of landing sites and access points as necessary.

5.3 Submarine Cable Laying Ships

Cable ships shall be equipped with dynamic positioning and dynamic tracking systems. Cable laying and trenching equipment, Remote Operated Vehicles (ROV), shallow water barge, shore-end jack-up barge, cable storage barge, and work boats shall be required for laying and repair operation.

Commentary Note:

Cable laying is normally performed using a recognized cable-ship after any necessary route clearance in shallow water has been carried out. Laying is normally undertaken only when weather and sea conditions do not create severe risk of damage to the submarine portion, cable ship and laying equipment, or of injury to the personnel.

5.4 Cable Burial

To increase cable protection, cables installed in shallow water shall be buried (refer to the shallow water definition). Trenching requirements are determined upon careful consideration of the balance between economics and safe operation and acceptable risk.

5.4.1 Burial Depth

The depth of burial depends on what is being protected against. For example, a cable may be buried deeper than the deepest expected dredging activity, deeper than an anchor will penetrate into the bottom when dropped, deep enough to avoid the flukes of a dragging anchor, or deep enough to avoid the abrasion of high tidal currents or surf. Proper burial survey must be conducted in advance to determine the required burial depth (see Appendix I for details on how to conduct burial assessment survey).

5.4.1.1 Cables crossing ship route corridor (navigation channel) shall be buried a minimum depth of 1 meter, including 20 meters long at each side of the navigation channel corridor.

5.4.1.2 Submarine cable shall be buried a minimum of 1 m, starting at the land disconnecting device to a water depth of 7.5 m below Lowest Astronomical Tide (LAT).

5.4.1.3 Submarine cable shall be buried in surf zone area. Beach joint (surf zone) trenching and burial shall comply with SAES-T-624 guidelines.

5.4.1.4 Submarine cable close to platforms shall be protected using Grout bags, made bags, mattresses, or equivalent methods.

5.4.2 Horizontal directional drilling may be used to install a conduit under part or all of a waterway. Commonly, this method is used to install conduit for the shore ends of a cable installation. Near shore and on land, concrete half-tiles are sometimes laid over the cable before it is backfilled to protect the cable from being dug into per SAEP-339.

5.4.3 Cables installed in deep water (refer to the deep water definition) and does not meet the above mentioned conditions; specially made bags ("mattresses") may be set over the cable and filled with concrete or gravel. Blankets or scour mats can be made of either tires or precast concrete blocks that are lashed together and laid over the cable. When heavy mattresses or blankets are used, the soil should be firm enough to support the mattress without settling and care should be taken to prevent the cables from being compressed by the mattresses.

5.4.4 Marine Dredging and Landfilling

Work permit and approvals shall comply with all Saudi Aramco procedures including SAEP-339 for marine dredging and landfilling.

5.5 Platform Transition

Submarine fiber cable shall be physically protected from the bottom of the jacket leg, to the point of cable armor termination, by a trough, tube, or direct mounting to the jacket leg. Cables shall not hang unprotected.

5.5.1 The cable armor shall be terminated in an armor clamp located in a vertical riser section below the cable disconnecting device. The clamp shall provide positive anchoring and grounding of the armor wires, in addition to terminating and grounding the inner flat armor tapes.

5.5.2 To enable the safe installation of the cable to the platform or riser deck, J-tube shall be used to ensure that all mechanical forces associated with pulling the cable are borne by the armor with minimal transference of strain to the internal cable. Proper filling material or proper accessories shall be installed at both ends of the J-tube to minimize any damage to the cable due to any subsea activities.

5.6 Cable Crossing

Crossing of other cable/pipeline as shall be avoided when minor rerouting is practical. When a crossover is required, the type of crossing and protection methods shall conform to SAER-5711 recommendations. The same protection requirements/methods highlighted in SAER-5711 is applicable to pipelines as well as power/fiber optics cables.

6 Testing and Inspection

6.1 Submarine fiber optic cables shall be tested in accordance with SAES-T-624. Submarine fiber optic cable test methods shall be in accordance with ITU-T G.976 "Test Methods Applicable to Optical Fiber Submarine Cable Systems".

6.2 All fiber strands shall be tested per wavelength, per direction per section and end-to-end using both OTDR and power meter.

6.3 Installation shall be inspected for safety, reliability and functionality of the whole system.

Revision Summary

31 January 2010	New Saudi Aramco Engineering Standard.
22 May 2012	Editorial revision to change the primary contact.
17 September 2013	Minor revision of SAES-T-919 deleting 18-SAMSS-625 which is not the correct material specification for submarine cables and aligned with 18-SAMSS-006 and 18-SAMSS-008.
6 February 2018	Overlay to International Standards ITU-T G.97x series and ITU-T G. Supplement 41.

APPENDIX I

LANDING (TOPOGRAPHIC) AND ONSHORE SURVEY

This task provides the topographic maps of the landing area on shore.

- A suitable sized area for the joint bay (site of junction between the submarine and land cables), is surveyed in order to provide the required topographic and physical data for the construction works.
- This survey provides results in appropriate format (graphics, text, multimedia) with regard to the morphology of the seabed (Echo Sounder and Side Scan Sonar), its nature (sub bottom stratigraphy, and video tape, picture, soil probing performed by divers).
- This task is carried out on all landing sites.
- The positioning is logged by Differential GPS (DGPS) with accuracy at surface typically in the range of ±1 m and navigation accuracy typically in the range of ±5 m on the survey track line.
- Once the survey is completed, the data, the complete results and the selected cable routes are transferred to the offshore team for continuing the survey.

OFFSHORE GEOPHYSICAL SURVEY

From the limit of the inshore surveys and with a convenient overlap that depends on the seabed morphology, the survey continues through shallow and deep waters, in order to collect the required data all over the assigned corridor.

- It is generally advisable to perform a high resolution bathymetric survey on a corridor width depending on the water depth, number of cables and seabed morphology.
- The on line processing is necessary in order to evaluate the results and to decide if more line survey is necessary.
- This survey should be performed by suitable Multi Beam Echo Sounder (MBES) all over the corridor and by Side Scan Sonar, in addition to a Single Beam Echo Sounder (SBES).
- Optionally a Sub bottom Profiler (SBP) (narrow beam) can be used in order to obtain qualitative information on the soil density.
- This data are necessary in case of cable burial.
- The results of investigation with electronic/acoustic systems should be integrated with soil sampling just with the purpose to verify the data collected and to help their interpretation.

- The Positioning system is the DGPS, and the navigation accuracy is typically within ±10 m off track.
- The navigation and data logging is performed by high tech navigation computer at state of the art.
- Determine sea bottom environmental sensitivity and ecological integrity.

BURIAL ASSESSMENT SURVEY

Along the selected cable route, a burial assessment survey (BAS) is generally carried out in areas where cable burial is required at the end of the geophysical survey.

- The BAS is the better way to achieve the required level of confidence about the expected burial level and, as a consequence, to define the main burial equipment and the corrective protections, if any, and to be implemented.
- The BAS may be performed by a vibrocore (VBC) spread sampling the route at defined intervals, for example every 1 km. Gravity cores and grab samples are also typically planned as a complement to the VBC.
- The vessel positioning system provides the same accuracy as per the cable survey.
- Thermal Resistivity Tests in site could be also required at different depth under the sea-bottom.

REPORTING AND CHARTING

Initial interpretation of data is normally carried out on board to enable the preliminary charts to be used for assessing the completeness of the data, and the planning of further survey or route deviations where necessary. Data can be unloaded from the vessel at time to time in order to allow the beginning of final processing in advance from the operations end. The reporting activity is focused on the preparation of a preliminary and final report. The latter will normally include:

- Scope of work
- Summary of the results
- Personnel and equipment used
- Geodetic and navigation parameters
- Diary of events
- Survey charts