Engineering Standard

SAES-T-914 21 May 2012

Communications Distribution Cable

Document Responsibility: Communications Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

This standard prescribes mandatory requirements governing the design, extension and placement of telecommunication outside plant distribution cable.

2 Conflicts and Deviations

Any deviations, providing less than the mandatory requirements of this standard require written waiver approval as per Saudi Aramco Engineering Procedure SAEP-302.

3 References

All referenced specifications, standards, codes, forms, drawings, and similar materials shall be of the latest issue (including all revisions, addenda and supplements) unless stated otherwise.

A. Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Engineering Standards

SAES-T-018	*Telecommunications Symbols, Abbreviations & Definitions*
SAES-T-631	*Communications Cable Terminals*
SAES-T-634	*Telecommunications - Cable Testing and Acceptance*
SAES-T-938	*Telecommunications - Outside Plant Systems Design*
SAES-T-912	*Telecommunications - Communications Feeder Cable*

B. Industry Codes and Standards

Building Industry Consulting Service International

BICSI Chapter 2	*Telecommunications Distribution Methods Manual*
BICSI OSP Chptr 3&9	*Customer-Owned Outside Plant Design Manual*

TIA-758-A	*Customer-owned Outside Plant Telecommunications Infrastructure Standard*

Rural Electrification Administration

REA PE-39	*Specification for Filled Telephone Cables (Solid PIC)*

4 Definitions

Addressable Locations: A service location that can be identified by a numbered address specified by Saudi Aramco to identify the physical location of a Saudi Aramco Housing Unit or Proponent Office Building.

Committed Pairs: Feeder cable pairs from the host or remote switching unit that are terminated on the feeder (IN) side of a connector. These cable pairs are multiple free and committed to a particular connector in 25 pair groups.

Dedicated Pairs: Cable pairs that are permanently assigned and have continuity from the central office main distribution frame or from a connector to a terminal.

Digital Connectivity Capability (DCC): Facilities that will support up to144 kb/s transmission requirements. That is, services which require up to this level of capability can be provided "on demand" with only special terminating equipment as required for the specific service. This capability is primarily a function of loop length parameters and grooming requirements for the copper network.

Commentary Note:

Transmission up to 144 kb/s and beyond can also be provided directly via fiber, coax, etc., without these considerations.

Distribution Facilities: Portions of facilities, which are:

- Located within a service section.
- Designated to serve only customers within the service section where they are located.
- Equipped with terminals for connection to service drops.

ESA: Electronic Serving Area - A geographic area that:

- Consists of one or more service sections.
- Is served directly by either a central office or digital pair-gain device.

FAC: Facility Area Connector - A device for connecting cable pairs mat originate at a central office (or at a remote terminal) with the distribution cable pairs within a facility area.

Facility Area (FA): A well-defined geographic area whose size is based on the number of housing units and user locations one Facility Area Connector (FAC) will serve.

Commentary Note:

Once the area boundaries are established by Planning and Engineering, the boundaries must be documented on outside plant records.

Facility Area Plan (FAP): A FAP consists of the following:

- A clearly defined area, called Facility Area, with dedicated distribution cable plant.
- A single cross-connect for each facility area, called a Facility Area Connector (FAC).

Fixed Count Terminal: Any terminal on buried or aerial cable that has a cable count designated by engineering personnel. It is the only count accessible for connecting subscribers to the network.

Housing Unit: A single-family residence or each unit of a multi-family residence such as apartment buildings.

Primary Pair: A cable pair permanently assigned from the connector to an addressable location. In new plant, cable pairs **are** cut **off** beyond their service connection **at** the time of cable placement.

Proponent Location: A building that is used to house one or more Saudi Aramco proponents. These include Saudi Aramco proponent buildings such as office building, schools, hospitals, administration office buildings, oil and gas producing, and other industrial building complexes, etc.

Reassignable Pair: A feeder or distribution cable pair that is not permanently assigned. These pairs are used to provide secondary lines to the connector and housing units or additional lines to business locations.

RDAP: Rural (Remote) Distribution Area Plan.

Ready Access Terminal: A terminal with full accessibility to the cable's compliment for service.

Commentary Note:

Saudi Aramco does not use this type of terminal.

RTs: Remote Terminals - A digital system with switching or pair-gain capability. It supplements feeder plant by using T1 or fiber span line connection to:

- The host office.

- Another remote switching terminal.
- A corresponding central office terminal.

Secondary Pair: A cable pair for second line residential service where a distribution pair, other than a primary pair, has been pre-assigned and committed to a housing unit. The bridge rap may be cut off as in the case of a primary pair. Those pairs that are not cut off are restricted to 1,000 feet beyond the first terminal appearance and/or three terminal appearances.

Service Section: A geographic area which:

- Is contiguous.
- Defines a distribution cable network/area administered as a unit.
- Is (normally) synonymous with a "facility area" where FAP and RDAP is implemented (refer to SAES-T-938).

Spare Flex-Dedicated Pairs: Pairs that are available to **be** assigned to any service address that falls within the wiring limits of that terminal. These pairs may or may not be cut off at the serving terminal.

Spare Pairs: Pairs in a cable, which are not terminated and are available to be assigned to any terminal in the distribution area where they appear. When spliced into a specific terminal, these pairs will be cut off at the serving terminal and become dedicated pairs.

Wiring Limits: A telecommunications station wiring administration method, which lists the specific residences or buildings (by house number or building number) that are to be served from a specific cable terminal.

5 Design

5.1 Distribution Cable Design

5.1.1 Recommended Design

The FAP design should be the first design considered for all new areas that qualify.

Commentary Note:

Transmission parameters of OSP Local Loops must comply with SAES-T-938, Outside Plant Systems Design.

The Conventional Distribution design ("Conventional Design" or CD) is the design for distribution cable to implement for all applications that do not meet FAP or RDAP application parameters (for parameters, refer to

SAES-T-938). Conventional Distribution design is explained below in Paragraph 5.3.

Commentary Note:

TIA-758-A "Customer-owned Outside Plant Telecommunications Infrastructure Standard" should be referred to for general design practices.

5.1.2 Cable Systems

In designing an adequate cable system, each feeder cable and distribution cable must be designed as a component part of the total system and not as an individual unit.

5.1.3 Distribution Cable Size

5.1.3.1 Size all facility area distribution cables on the basis of:

- Two (2) pairs per living unit (minimum).
- An estimate of service demand (i.e., one cable pair per nine (9) square meters of usable office space, per the BICSI, Telecommunications Distribution Methods Manual, Chapter 2, page 9).

Commentary Note:

Segregating distribution and feeder, functionality into its own cable sheath is a worthwhile objective, to the extent that multiple sheaths exist or new sheath is necessary. It may not, however, be prudent to place a new sheath if existing capacity is sufficient.

5.1.3.2 To help achieve acceptable transmission in the distribution network, design rules are used to control loop transmission performance. Loops shall be designed on a global basis to guarantee that:

- Loop transmission loss is statistically distributed.
- No single loop in the distribution network exceeds the signaling range or transmission objectives for the service to be provided.

5.1.4 Distribution Cable Gauge/Loading

Gauge distribution cables by using the Resistance Engineering to Measured Limits (REML) transmission design procedures, refer to SAES-T-938 and BICSI OSP Table 3.10 on pages 3-31 & 3-32.

Generally, no loading is required within the first 3,658 meters from the central office or remote terminal. If loading is required on any customer service within the facility area, the load coil spacing must be compatible with the loading arrangement used in the feeder cable complement that serves the loaded distribution complement.

Special service lines (e.g., Private Automatic Branch Exchange PABX trunks, data circuits, etc.), that require loading need individual attention. However, for administrative purposes, such circuits shall be contained within one or more 25-pair cable binder groups in the feeder cable. In the distribution cable, if loading is required, load the entire 25-pair complement.

5.1.5 Buried Distribution Plant

All direct buried distribution cables shall be filled core type cables. Refer to REA PE-39 for physical and electrical parameters.

Buried or underground cables should be placed along streets, alleys, and highways. Various methods of connecting the end user service to the distribution cable exist. Acceptable methods are:

(1) Terminals in handholes,

(2) Buried terminal housings,

(3) Pre-assembled buried cable (PRETERM).

Depending on the geography and buildings layout, the designer can select one or a hybrid of the following acceptable methods to implement:

(1) Place cable/terminals on one side only and have drops crossing the street.

(2) Place cable/terminals along both sides.

(3) Place cable along one side with cable/terminals lateral crossings for opposite side drop access.

5.1.6 Aerial Cable

Aerial type cable construction shall not be used except for temporary services.

5.1.7 Block Cable

Block cable on rear walls of buildings or on poles shall not be used except for temporary services.

5.2 Digital Connectivity Capability (DCC)

5.2.1 Remove all Analog Carriers Working within the Facility Area

Where feeder or distribution components serving adjacent facility areas have analog carrier in the same sheath, arrange to eliminate the carrier by using compatible facilities.

5.2.2 Bridge Tap Limitations

All cable pairs which are planned for use as digital connectivity pairs must be dedicated cable pairs which are multiple-free, and dedicated to an addressable location. All dedicated pairs are terminated and the field side cut dead ahead at the serving terminal.

5.2.3 Sheath Integrity

Sheath integrity of all distribution cables must be maintained to eliminate inadvertent disruption by workers. Existing ready access terminals are to be replaced with sealed fixed count terminals. Ready access splice cases are to be replaced with sealed cases.

5.2.4 Loop Treatment

On loops within 12,000 feet (3650 meters) of the central office and on loops, within 12,000 feet (3650 meters) of a remote terminal, existing loop treatment (e.g., load coils, build out capacitors, etc.) must be removed from the distribution cables.

5.2.5 Protection Bonding and Grounding

The Design Engineer shall review the existing distribution plant where construction activity is to take place (in pedestals and manholes where splicing, transfers, removal or placement of cable occurs), to ensure that the cable electrical protection devices and the bonding and grounding of cable sheaths meet current Saudi Aramco Standards. This activity is to include the physical inspection and testing of made ground electrodes. All non-complying items must be corrected. This is to include electrical protection devices, grounding, and bonding systems within existing buildings. The requirements of this paragraph apply to all projects and work orders.

5.2.6 Party Line Grouping

Each station on an existing party line shall be provided its own cable pair, when work is done in its distribution cable legs, to allow grouping

at the central office main frame. An alternative is to provide private line service if the necessary equipment is available.

5.3 Conventional Design

5.3.1 Conventional Distribution design is the design to implement for all applications that do not meet Facility Area Plan (FAP) or Rural Distribution Area Plan (RDAP) application parameters.

5.3.2 Design Application

There are three (3) different types of distribution plant within Conventional Design:

- Multiple Outside Plant (OSP) design (MOP).
- Dedicated Outside Plant (OSP) design (DOP).
- Interfaced Outside Plant (OSP) design (i.e., Cross-Connected).

If the feeder cable network functionality goes directly to a customer location, this is defined as Direct Fed Design (DFD).

5.3.2.1 Multiple OSP Design

Multiple OSP design (MOP) is where wire center cable counts (feeder counts) appear in more than one (i.e., "multiple") leg of distribution cable through spliced connections. Multiple designs create bridge tap conditions, which degrade transmission characteristics and adversely affect operational aspects of the network. Multiple cable counts shall not be permitted in new construction.

5.3.2.2 Dedicated OSP Design

Dedicated OSP design (DOP) is where wire center cable counts (feeder counts), which appear through spliced connections, do not appear in more than one terminal or one leg of distribution cable.

5.3.2.3 Interfaced OSP Design

Interfaced OSP design (i.e., Cross-Connected) refers to plant designed with an interface (e.g., cross-connect or facility area connector) distinguishing feeder/distribution functionality. Overall connectivity from the wire center to the customer is established by jumpering between the feeder and distribution

cable counts. This design is similar to FAP/RDAP except overall land usage is not known. The Saudi Aramco IT - Communication Engineering Division, Outside Plant Unit Supervisor, must approve use of this design method in writing.

5.3.3 Site survey must be performing prior to finalizing the design. The site survey must consider geographical features of the area, existing outside plant situations and conditions, locations of various building under construction, the near-future cable pair requirements.

5.3.4 Cable Fill Boxes

- Cable fill boxes (See Figures 1 & 2 below) are placed:
  - At the beginning of each facility taper point and branch facility route.
  - For every section of new cable plant proposed.
- A sufficient number of fill boxes are to be placed and shown to:
  - Indicate the growth patterns of the area under consideration.
  - Substantiate the engineering proposal for additions or rearrangements.
- A fill box as illustrated in Figures 1 & 2, or an engineering design drawing is placed as near to its point of reference as possible. If, for reasons of clarity, the fill box is not placed near its point of reference, a cross-reference method of identification is required.

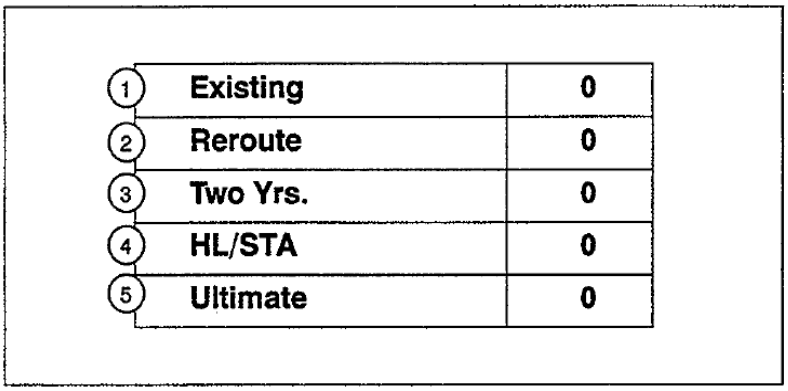

Figure 1 – Conventional Design Fill Box

Line	Enter.....
1	The existing, working cable pairs.
2	Any working cable pairs that are to be rerouted from one feed area or cable to the facility under study. (This line will illustrate cross-section condition when routed pairs are added to or removed from existing working pairs.)
3	The projected working pairs that will exist at the end of the second year.
4	The number of housing units or lots if fill box for FAP or RDAP. OR The number of stations (party lines) if the fill box is used for grooming (removing carrier, etc.) or conventional design.
5	The number of pairs using the appropriate FAP, RDAP, or grooming factor.

Figure 2 – Chart explains what to enter on each line of the Fill Box

5.3.5 Determining Cable Size

The Saudi Aramco IT - Communication Engineering Division, Outside Plant Unit should determine the distribution cable size needed based on their evaluation of future pair requirements and the outside plant network. Additionally, reinforcement for distribution cable shall be provided for, when the demand or usage of cable pairs results in Eighty Five (85) percent or higher fill by work orders or project job orders. In such cases, the work order or project job order shall be responsible for providing the cable reinforcement.

All distribution cable must be multiple-free and administered in 25-pair groups (Groups must not be split between branch cables.) The pairs per housing unit must be assigned by the engineer, permanently committed from the interface, and cut off beyond the Service connection point.

5.3.6 Determining Distribution Cable Taper Points

5.3.6.1 Distribution cables shall not be tapered in size until the cable size can be reduced at the taper by 50%.

5.3.6.2 Gauge and distribute conductors in distribution plant according to Resistance Engineered to Measured Limits (REML) transmission design procedures.

Commentary Note:

These procedures are outlined in SAES-T-938.

5.3.6.3 When determining taper points, the designer should consider the following:

- The need for construction forces to handle an extra reel of cable.
- Taper points involve having an extra straight splice.
- When one size cable is terminated and different sized cable starts a new operation in a continuous run, a discontinuity results in the cable-placing operation.

5.4 Terminals

5.4.1 Terminal Count

The count of terminals must be contained within a 50-pair group. Multiplying of terminal counts shall not be permitted in new cables. When cable re-arrangements are done, cable and terminal multiples on existing facilities must be eliminated at all work locations. This is not intended to include changing cable and terminal multiples on all cable legs, which change count as a result of re-arrangements at another work location.

5.4.2 Cable End Point

Where a future extension is not possible, clear and cap the cable at the last service requirement.

5.4.3 Combination Trunk and Exchange Cable

Combining direct, tandem, or other trunks in the same cable sheath with exchange facilities is not permitted.

5.5 Fixed Count Terminals

5.5.1 Existing multiple terminal counts are to be eliminated as the following design concepts are established:

- Digital Connectivity Capability (DCC).

- Facility Areas.
- Rural Distribution Areas.

5.5.2 Hardware

Use fixed count terminals on all new routine and specific work order construction. Standard symbols will be shown on work order drawings in accordance with SAES-T-018, Telecommunications - Symbols, Abbreviations and Definitions.

5.5.3 Providing Digital Connectivity

Design all new distribution cables and fixed count terminals with the ability to provide connectivity as follows:

- All cable pairs are multiple free and dedicated from the CO connector to the terminal point.

5.5.4 Converting to Fixed Count Design

In addition to new construction, existing ready-access plant if encountered on a project or job shall be converted to fixed-count design at all work locations.

5.5.5 Multipling Objectives

It is intended that multipling of cable pairs be eliminated in all of the Saudi Aramco Cable Network. Carefully consider the following objectives:

- Conform to ultimate relief plans by terminating all cable pairs within the limits of the ultimate area to be served by a section of cable.
- Distribute ultimate loads as evenly as possible throughout the cable.
- Avoid early congestion of any one terminal or cable pair count.
- Permit clear, concise records, thus simplifying engineering and assignment work.
- Facilitate splicing, fault locating, and clearing trouble.

5.5.6 Terminal Sizes

Size terminals to enable all distribution to be made from one terminal at each serving location. Requirements in SAES-T-631, Communications Cable Terminals, must be followed as applicable.

Replacing terminals: the sizing must be based on existing need by using:

- Assignment records.
- Recorded subdivision plats.
- Condition of existing units.
- Type of service.
- Existing congestion and pair spread of existing terminal.

6 Installation

Telecommunication distribution cables shall be placed in such a manner as to avoid damaging the outer sheath, shield, and/or the conductors contained within the sheath. All installations shall comply with this standard and other applicable standards as referenced in paragraph 3 above.

7 Testing and Inspection

After installation, all cables shall be tested in accordance with SAES-T-634 using approved testing apparatus. The Saudi Aramco Inspection Department must be notified two days in advance of testing schedule. Copies of all approved design variations must be provided to the Inspection Department.

Revision Summary

10 February 2009	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.
16 June 2010	Editorial revision to change the Primary Contact Person and remove the committee members list.
21 May 2012	Editorial revision to change the primary contact.