Engineering Standard

SAES-T-938 28 January 2004
Telecommunications:
Outside Plant Systems - Design

Saudi Aramco DeskTop Standards

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I Scope

This Standard prescribes mandatory requirements governing the design and engineering of telecommunications outside plant systems. Facility Area Plan (FAP) design is covered. Data for Central Office Loop Resistance Limits is also included.

II 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.

III References

All referenced Specifications, Standards and Codes, Forms, Drawings and similar material shall be of the latest issue (including all revisions, addenda and supplements) unless stated otherwise. Applicable references are listed below.

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 and Definitions*
SAES-T-624	*Telecommunications Outside Plant - Fiber Optics*
SAES-T-634	*Telecommunications - Cable Testing and Identification*
SAES-T-912	*Communications - Feeder Cable*
SAES-T-914	*Communications - Distribution Cable*

B. Industry Codes and Standards

General Telephone and Electronics

IV Design

The GTE 938 Series is hereby recognized as Saudi Aramco Engineering Standard SAES-T-938, "Telecommunications: Outside Plant System - Design". Mandatory items and modifications are listed herein.

4 MODIFICATIONS TO GTE 938 SERIES

The following paragraph numbers refer to GTE 938 Series "Outside Plant Systems-Design", which is part of this standard. The text in each paragraph below is an addition, exception, modification, or deletion to GTE 938 as noted. Paragraph numbers not appearing in GTE 938 are new paragraphs to be inserted in numerical order.

4.1 GTE Section 938-010-070: Outside Plant Facility Area Plan (FAP) Design; Issue 4/Jan., 1991

4.1.1 General

4.1.1.1 Paragraph 1.1 - This section covers Facility Area Plan (FAP) design for telecommunications outside plant feeder and distribution cables.

4.1.1.2 (Addition) For conventional cable design (non-FAP), refer to SAES-T-914, Communications Distribution Cable.

4.1.2 Overview

4.1.2.1 Paragraph 2.1 - This standard positions the telecommunications distribution network for compliance with Integrated Services Digital Network (ISDN) basic access as well as POTS. This standard not only meets ISDN and POTS technical standards, but also preferred operational design standards.

The following list provides some of the key ingredients for this distribution design standard:

- Distribution network interface to the feeder network via a Facility Area Connector (Cross Connect) of the binding post type.
- Fixed Count terminals with threaded lugs or binding post connections.
- No cable count multiplying.
- Elimination of bridge tap conditions.

- Absence of analog station/subscriber carrier.

4.1.2.2 Paragraph 2.2 - Consider the FAP concept only when the total Saudi Aramco land usage is known and the ultimate pair requirements can be determined. Use conventional design in:

- Remote areas not suited to Rural Distribution Area Plan (RDAP).
- Areas where land usage has not been determined.

Do not use the FAP (as described in this section) to serve predominantly office or industrial complexes because of the extreme changes in service requirements.

4.1.2.3 Paragraph 2.3 - Definitions. Some of the terms associated with facility area planning are defined below.

Addressable Locations: For plan administration purposes, all services within a facility area must be identified by an address.

This must be the house number or building number:

- Specified by Saudi Aramco to identify a Saudi Aramco housing unit or proponent 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
- 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. All dedicated pairs are cut dead ahead at their terminal appearance, and do not have any bridge tap.

Digital Connectivity Capability: Facilities that will support up to 144 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
- 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.

Facility Area (FA): A well-defined geographical area. Its size is based on the number of housing units and user locations one Facility Area Connector (FAC) will serve. Once the area boundaries are established by Planning and Engineering, the boundaries must be documented on outside plant records.

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

Facility Area Plan (FAP)

Feeder Facilities: Portions of facilities, which form a "pipeline" from a central office (or remote terminal) to and/or through one or more service sections.

Housing Unit: A single-family residence, or each unit in a multifamily building (such as an apartment building).

Proponent Location: A building that is used to house one or more Saudi Aramco proponents. This includes any Saudi Aramco proponent building such as:

- Office buildings, schools & hospitals.
- Administration office buildings.
- Oil & Gas producing & other industrial buildings.
- Etc.

RDAP: Rural (Remote) Distribution Area Plan

Remote Terminal (RT): A digital system with switching or pair gain capability. It supplements feeder plant by using E1/T1 or fiber span line connections to:

- The host office.
- Another remote switching terminal.
- Corresponding Central Office Terminal.

4.1.3 Considerations

Paragraph 3.1 - The Facility Area Plan (FAP) design is ideal when it is

applied to predominantly residential areas with few office users, provided that sufficient spare cable pair allowances are made to handle any unusual demands for service at the office locations.

The FAP consists of the following:

- A clearly defined area (a facility area) with dedicated distribution cable plant.
- A single cross-connect point for each facility area. It connects the distribution and feeder cable pairs.
- Main feeder facilities sized on an economic selection basis.
- Feeder cable with adequate pairs that complements the FACs to meet short-term line requirements (usually two to five years).

(Refer to GTE 938-010-070 pages 8 and 24-30 for detailed Exhibits of FAP).

4.1.4 Facility Area Plan Design

4.1.4.1 Paragraph 4.1 - Facility Area Plan (FAP) Designs-General.

Because of existing plant conditions, not all areas will initially be able to adapt to pure FAP.

When the FAP design concept is applied, the following components must be specified (see Figure 3 on page 23):

- Feeder cable and route design.
- Facility area size and boundaries.
- Connector size and location.
- Feeder pairs committed to the connector in a minimum of 25-pair binder groups.
- Distribution cables, sized based on the ultimate requirements of the facility area.
- No multiplying of distribution cable pairs.

4.1.4.2 Paragraph 4.2 (Modify) - When designing distribution cables and pairs within facility areas in new or rearranged plant, ensure that the:

- Distribution cables will provide:
  - A minimum of two dedicated pairs for each living unit.

- Cable pairs for the ultimate special service requirements, user line requirements and all miscellaneous line requirements.
- Not more than 10 housing units assigned per 25 pair cable count.

- Distribution cables are:
  - Multiple-free.
  - Administered in minimum size groups of 25 sequential pairs.
- Distribution cables in FAP areas which serve housing units must:
  - Provide sufficient spare pairs (minimum of five per 25 pair group).
  - Cut all pairs off (cut dead ahead) beyond the point of connection (terminal).

4.1.4.3 Paragraph 4.3 - Areas that do not qualify for FAP or Rural Distribution Area Plan (RDAP) design, (see paragraph 4.2 below) must be designed or maintained under conventional cable design methods as described in SAES-T-914.

4.1.5 In-Depth Engineering Required

4.1.5.1 Paragraph 5.1 - General Requirements. In-depth planning is a prerequisite of establishing a facility area. The planning forces have this responsibility and facility areas must not be established in either new or existing plant until planning is completed for a given area or route. All FAP plans must be designed by or approved in writing by the Saudi Aramco Communications Engineering Division of IT. This includes any changes to the feeder or distribution cables, count designations or the housing units served by the designated service terminal.

4.1.5.2 Paragraph 5.5 - The Saudi Aramco Communications Engineering Division of IT, will design and engineer or approve in writing all FAP designs and determine:

- The ultimate number of housing units and proponent locations to be included in a facility area.
- The distribution cables, which will require immediate or future relief or replacement.
- Where new distribution cables will be required.
- The immediate or future rearrangements necessary in the distribution cables and terminals.

- Where main feeder cable relief is required.
- Rearrangements necessary in the feeder cable(s).
- The boundaries of the facility area, which must be documented in the:
  - Outside plant records so that plant forces know which terminals, splice closures, or service connection points would be included.
  - Fundamental plan, to ensure that future additions do not exceed the boundaries.
- How many immediate and ultimate feeder pairs will be required for the facility area. The connector size determines the size of the feeder stubs.
- How using committed feeder cable pairs at the connector affects the pair requirements for the balance of the feeder route.

After these determinations have been made, the details for implementing the FAP can be prepared.

4.1.6 Facility Area

4.1.6.1 Paragraph 6.1 - The FAP applies predominately to residential areas. Under the FAP design method, the applicable areas are divided into geographical sections called "facility areas." These areas are established when:

- The land use is zoned residential and development is complete or in progress.
- Sufficient knowledge of the ultimate development is available.

While the FAP design can serve Saudi Aramco residential areas with scattered small offices, it is not desirable to apply FAP to strictly office or industrial areas because the requirements:

- Are difficult to anticipate.
- Fluctuate with the different types of businesses involved.

4.1.6.2 Paragraph 6.2 - The size of the facility area may range from 50 to 600 housing units plus small proponents' requirements. It is based on the ultimate:

- Number of residential units.
- Cable pairs for Saudi Aramco proponent offices and miscellaneous services.

4.1.6.3 Paragraph 6.3 - The facility area boundaries must follow natural or man-made boundaries, such as roads, railroads, etc., where possible. Indicate Saudi Aramco facility area boundaries on work orders, schematics, and Construction prints.

4.1.7 Distribution Cable Design

4.1.7.1 Paragraph 7.1 - FAP design should be the first consideration for all new areas that qualify. Use the most economical adaptation to gain the benefits of the FAP design with a minimum of capital and expense cost at the earliest practical date.

4.1.7.2 Paragraph 7.2 - Size all facility area distribution cables on the basis of the availability of the best housing unit information and estimate of service growth.

All new distribution cable within a facility area must extend from the connector in its own sheath even when it extends parallel to a feeder cable.

4.1.7.3 Paragraph 7.3 - Gauge distribution cables by using either the Expected Measured Loss (EML) or the Resistance Engineering to Measured Limits (REML) transmission design procedures.

Commentary Note:

These are outlined in GTE Sections 832-100-072 and in paragraph 4.3 below.

Generally, no loading is required in the first 3,658 meters (12000 feet) of the central office or remote serving area.

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, Private Automatic Branch Exchange (PABX) trunks, data circuits, etc., that require loading need individual attention. However, for administration purposes, such circuits must be contained within one or more 25-pair cable binder groups in the feeder cable. In the distribution cable, it may be advantageous to load the entire 25-pair cable complement.

4.1.7.4 Paragraph 7.4 - Distribution cable pairs terminated in the connector are assigned a consecutive pair count starting at pair one regardless of the number of distribution cable sheaths. The assignment of pair count to cables in the distribution network is on the basis of uniform 25-pair binder groups.

Terminate all cable pairs when a distribution cable is placed in a connector. Distribution cables leaving a connector must not have any dead pairs or dead complements.

4.1.7.5 Paragraph 7.5 - All distribution terminals must be:

- Identified. All terminal counts are assigned or approved by the Communications Engineering Division of IT,
- Fixed count whether buried or aerial.
- Given an assigned count equaling a minimum of two cable pairs per living unit located within the wiring limits of the terminal.

Additional pairs, as required (present and future), shall be provided for special services and business line requirements.

4.1.7.6 Paragraph 7.6 - Terminal cable pair counts must not split 50-pair groups.

4.1.8 Feeder Cable Design

4.1.8.1 Paragraph 8.1 - Requirements for Design. The design of feeder cables require:

- Forecasting growth in well-defined geographic areas.
- Provisions for complete interconnection between distribution and feeder plant.

4.1.8.2 Paragraph 8.2 - Feeder pairs are committed to the connector in 25-pair complements. Do not commit in less than 25-pair complements.

Assigned feeder cable pairs in the connector must be multiple-free.

Adequate feeder cable pairs must be assigned to a connector to provide for:

- Existing service.
- Approximately two to five years of forecasted growth within the facility area involved.

Once a feeder cable pair complement is committed to a connector, it should not be reassigned to another connector or another use.

Committed feeder cable complements must not appear in more than one connector, and must not have distribution terminals or distribution cables in the feeder cable connected to these committed complements.

When a feeder cable complement is committed to a facility area, cut off the complement beyond this point. This arrangement will eliminate multiples or bridge tap on the feeder complements committed to the facility area.

All loops longer than 5,486 meters require loading. Physical pairs used for PABX Trunks exceeding 3,658 m must be loaded.

4.1.9 Facility Area Connector (FAC)

4.1.9.1 Paragraph 9.1 - The connector is a device for interconnecting feeder plant to distribution plant. Feeder and distribution cable pairs must be fully terminated to facilitate interconnection of any distribution cable pair to any feeder cable pair. Refer to Figures 2 and 3 on page 23.

4.1.9.2 Paragraph 9.2 - Size the connector, for the ultimate requirements of the facility area, whether it is placed in new or existing plant.

Determine the size of the connector by the total number (ultimate) of cable pairs to be terminated, both feeder and distribution. An example of connector sizing follows:

Step in sizing the connector

1. Assume that a serving area will ultimately contain:
   - 360 living units.
   - 10 office locations.
2. Provide a minimum of two pairs per living unit for the distribution and assume that:
   - 1.5 pairs per living unit would satisfy the feeder requirements.
   - The 10 business locations will ultimately require 50 pairs.
3. Multiply the number of living units (360) by 2.0 pairs. Add pairs required for office locations (50) to determine the total distribution requirement (770).
4. Multiply the number of living units (360) by 1.5 pairs, then add pairs required for business location (50) to determine the total feeder requirement (590).
5. Determine the connector size:
   - Take the largest cable pair requirement (770), normally the distribution.

- Double the amount.
- This equals the sum (1,540) of terminations required for the connector.

6. The connector selected (1,800 pairs) should be the nearest size larger to the ultimate number of terminations (1,540) required.

Commentary Note:

The estimates are for this example only. Individually determine the allowable number of pairs (either feeder or distribution) for each unit in the facility area.

4.1.9.2.1 (Addition) Listed in Table 1 are some of the cross connect cabinets that are currently being used by Saudi Aramco:

Table 1 - Cross Connect Cabinets

Total Pair Size	SAMSS Stock Nos.
400	18-013-150
800	18-013-155
900	18-013-100
1200	18-013-160
1800	18-013-165
2700	DC ITEM

4.1.9.3 Paragraph 9.3 - Cables terminated in the connector must be even-count PIC cables.

4.1.9.3.1 FAC Entrance Cables can combine "In/Out" in the same sheath or be placed in separate sheaths for feeder and distribution pairs. Entrance cables/stubs must be sized to serve the maximum capacity of the connector at the time of FAC installation.

Commentary Note:

Terminate all entrance pairs at the time of installation.

Size the connector feeder cable stub to facilitate the ultimate number of connections on the feeder portion of the connector. Terminate all feeder pairs and show them on the work order, whether initially energized or not. (See Figure 2 page 23).

- All splicing must be done outside the FAC (i.e., in another closure or manhole) Cabinet.

4.1.9.4 Paragraph 9.4 - Connector Location. In selecting the connector location, the design used must:

- Allow room for the doors of the connector/cabinet to open fully and provide adequate workspace around the connector.
- Assure safety to employees and public. The location must provide safe working and parking conditions. The site should be away from traffic, if possible. When cabinets are located near streets and highways, the doors should open away from traffic so technicians will be positioned farther away from traffic flow.
- Assure permanency, since relocating an installed connector is expensive.
- Promote good public relations.
- Avoid vulnerability to damage by vehicular traffic. Pipe guards are required when directed by the Saudi Aramco Communications Engineering Division of IT. (Ref. Dwg. #AB-036266)
- Avoid likely flooding areas.
- Provide concrete pad foundations.

4.1.9.4.1 The location of the connector within the facility area is an important economic factor. Place the connector in the quadrant of the facility area nearest the feeder cable. (See Figures 5 and 6 on page 25).

4.1.9.4.2 Paragraph 9.5 - Connector Identification. The following connector information is required on all projects:

- Identification (Address).
- Type and size.
- Cable pair "IN" count.
- Cable pair "OUT" count.

4.1.10 Converting Existing Plant To Facility Area Plan (FAP) Design.

4.1.10.1 Paragraph 10.1 - Not all-existing Saudi Aramco residential areas are qualified to convert to the FAP. Good candidates are residential areas where:

- The development is nearing the ultimate housing capacity.
- It appears that converting to this concept could gain feeder pairs in the feeder route.

4.1.10.2 Paragraph 10.2 - Feeder Cable. At the cutover of a new connector, the committed pairs must be sufficient to cover cutover plus a two to five year

growth.

4.1.10.3 Paragraph 10.3 - Distribution Cable. Each facility area must have only one cross-connect terminal. During conversion, remove any type of cross-connect facility located within an area being converted to a facility area. This does not include terminals located inside office buildings.

Distribution cables within existing plant of a facility area must meet the same requirements described in paragraph 4.1.4.

4.1.10.4 Paragraph 10.4 - Distribution Terminals. Cable pairs must be available for conversion in each distribution terminal. At this time, correct:

- All service wires so that they work within the wiring limits of the proper terminal.
- Other undesirable drop-wire routing or conditions.

Ready-access terminals and/or buried terminal housings in existing cables must be:

- Converted to fixed count, as work is required.
- Given a count not exceeding one 50-pair cable binder group.

4.1.11 Paragraph 11 - Facility Area Plan Symbols

See SAES-T-018 for standard FAP design symbols.

4.2 GTE Section 938-010-071, Outside Plant Rural Distribution Area Plan Design.

4.2.1 General

4.2.1.1 Page 2 - This section covers the Rural Distribution Area Plan (RDAP) design.

Commentary Note:

Word "Rural" as used in this section is understood to include "Remote" for Saudi Aramco purposes.

4.2.2 Definitions

The following gives the meanings of terms used in this section.

Commentary Note:

For additional related definitions, refer to paragraph 4.1.2.3.

Remote Area: Isolated or remote locations such as Saudi Aramco areas at, or near GOSP's or WIP's, etc.

Rural Area: Locations with density factors resulting in less than one service per acre and reasonable expectations of not exceeding that density within the ten year planning period.

Where smaller lot sizes and higher densities are encountered in isolated pockets in rural areas, treat isolated pockets (like mobile home parks, housing tracts, recreational areas, etc.) as urban areas.

Rural Distribution Area: A geographical area where 100% land usage for housing or industrial has not been defined.

All distribution cable plant is fully dedicated and provides a minimum of one pair per housing unit (existing and forecasted). Once established, the boundaries of a rural distribution area should be documented on outside plant records.

Rural Distribution Area Connector: A device for connecting feeder and distribution cable plant at each rural distribution area. It provides the means to cross-connect feeder plant to distribution plant. Connectors are:

- Established under engineering work orders.
- Introduced into either new or existing plant.

4.2.3 Considerations, Benefits, and Objectives

4.2.3.1 Page 5 - RDAP Considerations. The RDAP is to be applied only to predominately rural areas, like Housing/Recreational areas near GOSPs or WIPs. It is not suitable to offices or industrial complexes and other areas subject to extreme changes in service requirements.

In practice, the RDAP consists of:

A clearly defined geographical area (remote distribution area) with dedicated distribution plant that:

- Provides a minimum of one cable pair per housing unit or small office location (including forecasted requirements).
- Provides a single interface point for each remote distribution area. The interface point is a connector:
  - Used between the distribution plant and the feeder plant.
  - Generally located at load points.

- Provides carrier equipment placed at the interface (if carrier equipment is used).
- Consists of feeder cable pairs and/or carrier circuits committed to Rural Distribution Area Connector's (RDAC) to meet the short-term requirements (generally 2 or 3 years). For feeder cable design requirements, refer to SAES-T-912.
- Consists of feeder cables and/or carrier systems sized on an economic selection basis.
- Consists of digital pair gain placement for Integrated Services Digital Network (ISDN) compatibility. Reference GTE 002-040-070.

4.2.3.2 Refer to GTE 938-010-071, Page 6, for a listing of RDAP Benefits and Objectives

4.2.4 Rural Distribution Area

4.2.4.1 Page 6 - Rural distribution area boundaries are determined in one of two ways.

- The first method involves drawing the boundary at the point on a rural cable route beyond which all existing or proposed facilities are sized for one circuit per housing unit (plus forecasted growth). Generally, the cable requirements in these areas will be:
  - 50-pair or less.
  - Classified as distribution cable.

Commentary Note:

GTE 938-010-071, Exhibit 1 gives an example of remote distribution area boundaries determined by cable size.

- In the second method, boundaries are defined by load sections. Each load section is designated a rural distribution area and is used to define distribution areas along the rural feeder cable (as shown in GTE 938-010-071, Exhibit 1 on page 15).

4.2.5 Remote Distribution Cable

4.2.5.1 Page 7 - Size all remote distribution cable on the basis of the best available information regarding:

- Housing units.
- Forecasts of service.

Provide at least one distribution cable pair for each existing and forecasted (see 5 Year Plan, etc.) housing unit or proponent location. Economic analysis must determine if the distribution pairs should extend back to the central office by way of dedicated feeder plant or if a connector should be used between feeder and distribution cable plant.

Commentary Note:

Studies should show a savings before a connector is used.

4.2.5.2 Page 7 - Minimum Size of Distribution Facilities.

Table 2 gives the minimum sizes of rural distribution plant.

Table 2 - Minimum Sizes of Rural Distribution Plant

Condition	Minimum Cable Size
Saudi Aramco Roads and Other Roads/Highways	Twenty Five-pair cable
All buried drops less than 305 meters long	Two-pair 22-gauge filled buried service wire
If the total length of a rural service drop would be more than 305 meters	Then place minimum of 25 pair filled cable

Commentary Note:

All cables must be multiple-free.

4.2.5.2.1 Distribution Cable Gauge:

Gauge distribution cables by using the Resistance Engineering to Measured Limits (REML) transmission design procedures.

Commentary Note:

Refer to GTE Section 832-100-072 and paragraph 4.3 below for instructions.

4.2.5.3 Page 7 - Distribution Cable Count - Assign a consecutive pair count to distribution cable pairs terminated in the connector. Start at pair one regardless of the number of distribution cable sheaths.

Assign pair counts to cables in the distribution network on the basis of uniform 25-pair binder groups. This pair count sequence has the advantage of maintaining color codes.

Commentary Note:

Refer to GTE 938-010-071, Page 8 for an example.

4.2.5.4 Page 8 - Distribution Cable Loading - If loading is required on any customer service within the remote distribution area, the load coil spacing must be compatible with the loading arrangement used in the feeder cable complement that serves the loaded distribution complement.

Cut off loaded distribution cable pairs on the office side of the load coil at the next load point beyond the customer's service connection. Do not cut them off at the customer's service connection point.

4.2.6 Feeder Cable

4.2.6.1 Page 8 - Feeder Cable Size - Using pair gain systems or equivalent is a major factor to consider in any plan. Consider using them in the initial or future plan for a remote distribution area where they may provide:

- Increased service reliability.
- Economic advantages.

New feeder cable in rural/remote areas should usually provide sufficient pairs for the 10 year forecasted line requirements.

Strongly consider using screened or fiber optic cables for potential pair gain applications.

Decisions involved in this paragraph will be made by the Saudi Aramco Consulting Services Department, Electrical Systems Division, Communications & Computer Networks Unit (CCNU) and included in the Scope of Work.

4.2.6.2 Page 9 - Feeder Cable Gauge - Gauge feeder cables using Resistance Engineering to Measured Limits (REML) design procedures. The GTE 832-100-072 Series and paragraph 4.3 below outline the procedures.

4.2.6.3 Page 9 - Feeder Cable Count - Label feeder cables with the standard central office (CO) cable number and count designation. Show what enters connector involved, e.g., cable number and count of compliments of feeder pairs that are committed to a remote distribution area.

4.2.6.4 Page 9 - Committing of Feeder Pairs to Connector - Obtain sufficient knowledge of present and future relief before committing feeder pairs to a connector. The RDAP is designed for periodic additions of feeder cable

counts. Therefore, eliminating excessive stubbing arrangements of feeder cable counts is very important in maintaining orderly plant.

Assigned feeder cable pairs in a connector must be multiple-free.

Assign adequate feeder facilities to a connector to provide for:

- Existing service.
- A minimum of two to three years of forecasted growth within the rural distribution area.

Feeder cable pair complements committed to a connector must not have distribution terminals or distribution cables in the feeder cable connected to these committed complements.

Never use the distribution count (OUT count) of a connector as the feeder (IN) count of another connector.

When a feeder cable pair complement is committed to the rural distribution area and spliced to the stub cable of the connector, cut off the complements beyond this point. This arrangement:

- Eliminates multiples or bridge taps on the feeder complements committed to the remote distribution area.
- Makes the complements available for future relief counts to be used beyond that point.

4.2.6.5 Page 9 - Feeder Cable Relief - Converting existing plant to the RDAP could provide adequate relief without additional feeder cable. Therefore, consider conversion before additions. Relief might also be provided, when economical, by means of pair gain before it is necessary to add feeder cable. Generally, existing rural cables will not support digital pair gain applications and it will be necessary to place screened or fiber optic cable.

Avoid cable transfers between main feeder cable routes. These transfers are generally:

- Not economical (even on a temporary basis).
- Contrary to fundamental planning.

4.2.7 Page 10 - Rural Distribution Area Connector. Refer to page 10 in GTE Section 938-010-071 for additional information on using Rural Distribution Area Connectors.

4.2.7.1 Page 10 - Size the connector to serve the total forecasted requirements (ultimate feeder and distribution requirements) of the Rural Distribution Area (when placed in new or existing plant).

4.2.7.2 Page 10 - When locating the connector follow paragraph 4.1.9.4 above.

4.2.8 (Addition) Refer to page 13 of GTE section 938-010-071 for additional information on conversion of existing plant to the Remote Distribution Area Plan (RDAP).

4.2.9 (Addition) Cable Television (CATV) Design information will be placed in the proposed standard, SAES-T-871.

4.3 GTE Section 938-204-071, Office Loop Resistance Limit Customer Loops; Local Central Office (CO) Limits

4.3.1 General

4.3.1.1 Paragraph 1.01 - This section provides procedures to be used by Saudi Aramco Telecommunications to determine the conductor loop resistance limits of central offices (CO). This data is to be used when designing copper conductor cable networks.

4.3.1.2 Paragraph 1.02 - (Addition); This section specifies the conductor loop resistance limits of central offices (CO), as shown below:

4.3.1.2.1 Cable Design and Resistance Considerations (Ref: Figure 4, page 24).

4.3.2 Paragraph 2.08 - Central Office (CO) External Resistance Limit - This is specified by the manufacturer as the maximum resistance external to the CO. When this maximum resistance is added to the battery feed device resistance and office wiring resistance, it will provide the data needed to determine the minimum amount of current required to properly operate the switching equipment. CO internal resistance is normally 400 ohms, and voltage is normally 48 or 50 VDC.

4.3.2.1 Paragraph 2.09 - CO External Loop Resistance - this is the total of:

- Conductor Loop Resistance (R2) (See paragraph 4.3.2.2 below).
- Loop Treatment Resistance (R1) (See paragraph 4.3.2.3 below).
- Station Terminating Resistance (See Paragraph 4.3.2.4 below).

Commentary Note:

Refer to Figure 4.

4.3.2.2 Paragraph 2.10 - Conductor Loop Resistance (R2) - This is the resistance of the cable pair at the maximum expected operating temperature as measured from the customer's station protector to the line side of the Main Distributing Frame (MDF). Conductor loop resistance includes the resistance of:

- The cable pair at the maximum expected operating temperature as measured from the customer's distribution cable terminal to the MDF.
- Any load coils.
- Any Building Out Lattices (BOLs).
- The drop, service wire, or entrance cable to the station protector.
- Any carrier filters (remote from the CO).

4.3.2.3 Paragraph 2.16 - Loop Treatment Resistance (R1) - This resistance stems from the following sources:

- Heat coils (electromechanical offices only).
- Loop Extenders (LEs).
- Voice-Frequency Repeaters (VFRs).
- Bridge lifters.
- Carrier filters (located within the CO).
- Other equipment in series with the overall loop.

4.3.2.4 Paragraph 2.18 - Station Terminating Resistance - A maximum resistance of 430 ohms is allowed beyond the station protector (on the user's side).

4.3.3 Refer to Exhibit 1 for the Saudi Aramco Central Office Conductor Loop Resistance Limits.

4.3.4 Temperature Considerations

4.3.4.1 Paragraph 5.01 - Copper conductor cable loops shall be designed so as not to exceed the central office equipment resistance limits, at the maximum ambient temperatures. The loop design shall never exceed the CO conductor loop resistance limit unless loop extenders are specified as part of the loop design. See Exhibit 1.

For Saudi Aramco operating areas the minimum design temperatures shall be as follows:

Buried and Underground	43°C
Aerial on Pole Lines	65°C
Above Grade in Conduits or Trays	71°C

4.4 GTE Section 938-624-000, Optical Fiber Cable - General Outside Plant Design Considerations

This GTE section is included in SAES-T-624 (Telecommunications; Outside Plant - Fiber Optics)

V Installation

The installation of all cables shall comply with the applicable standards (see paragraph 3 above) and with general requirements related to land use, clearances, road or pipeline crossings, etc.

VI Testing and Inspection

The testing and inspection of copper conductor cables shall be done in accordance with SAES-T-634 (Telecommunications - Cable Testing And Acceptance).

Revision Summary

28 January 2004	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.

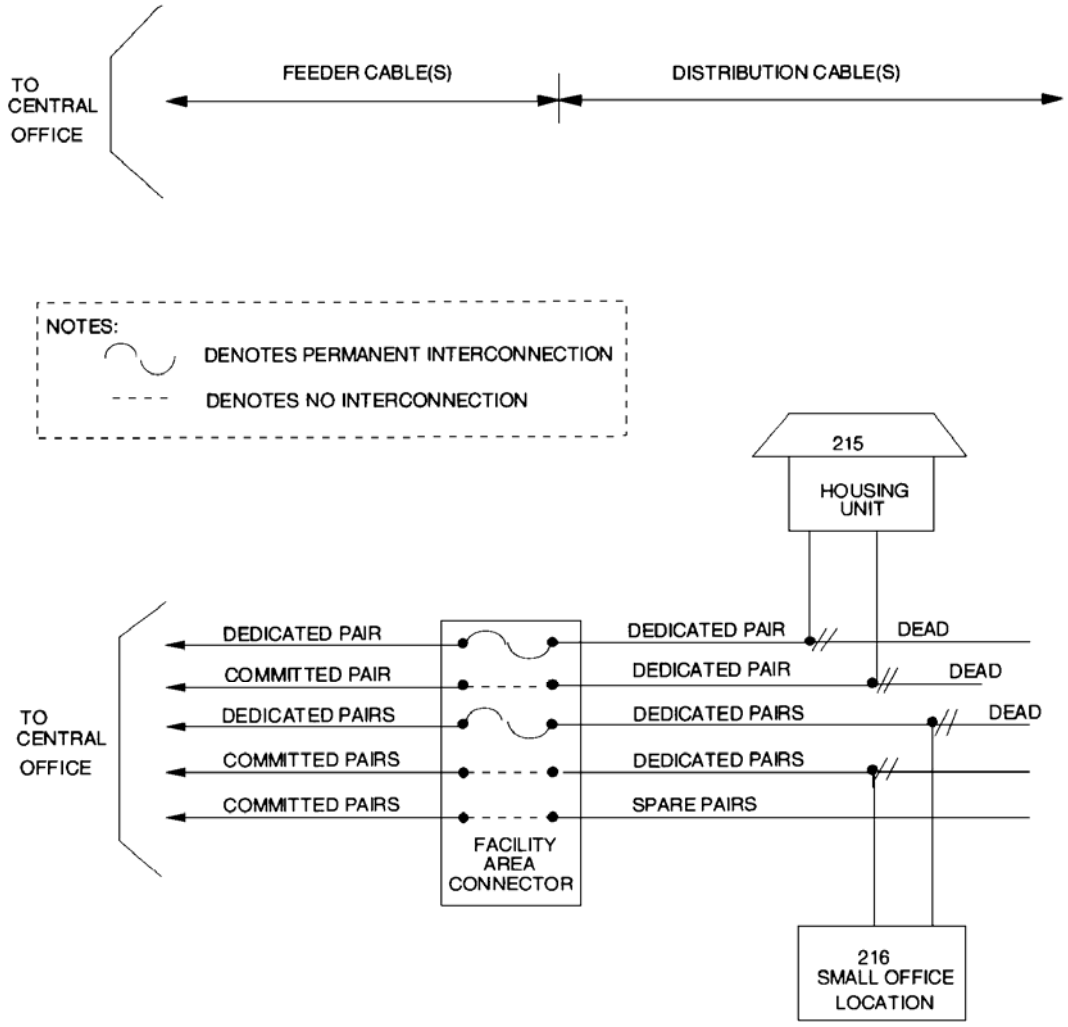
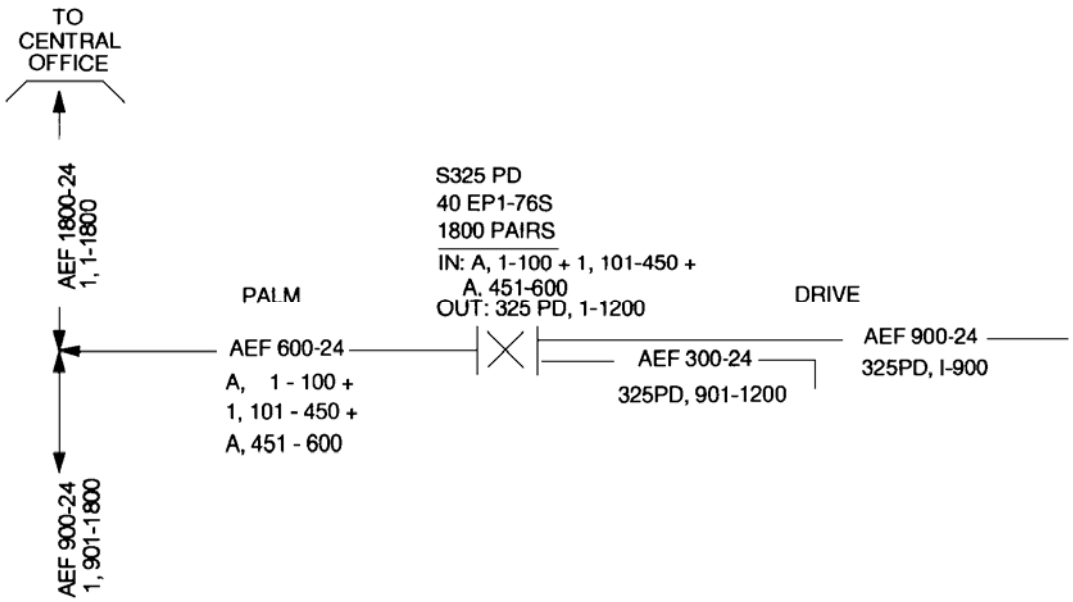


Figure 1 - FAC Schematic and Cable Pair Designation



Notes:
1. Terminate all feeder and distribution pairs and show them on the work order whether initially energized or dead.
2. Initial committed pairs to be terminated on connector binding posts 101-450.
3. Pairs, which are dead in sheath initially terminated on connector binding posts 1-100 and 451-600.

Figure 2 - FAC Cable Connections

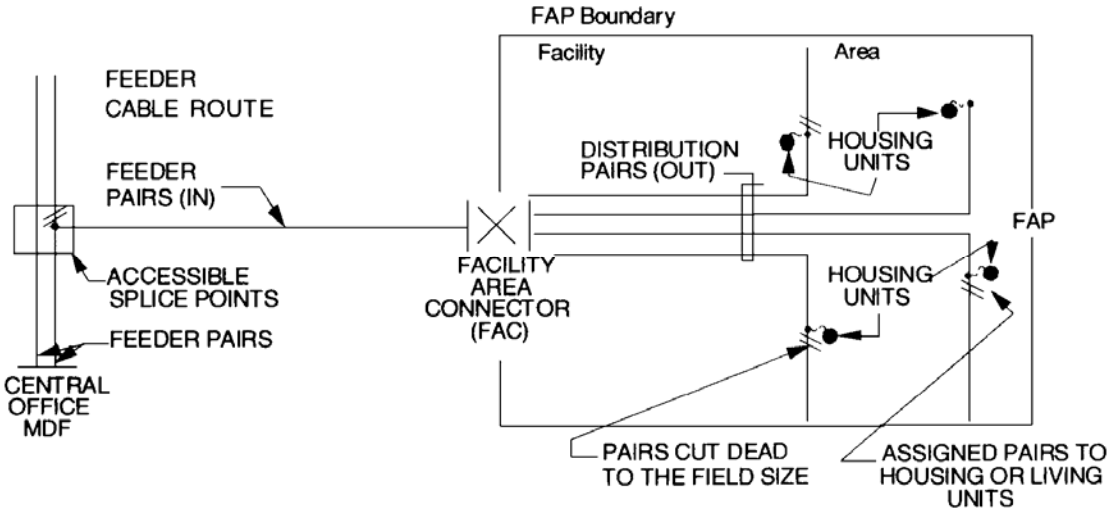


Figure 3 - Drawing Illustrates the Component Parts of FAP

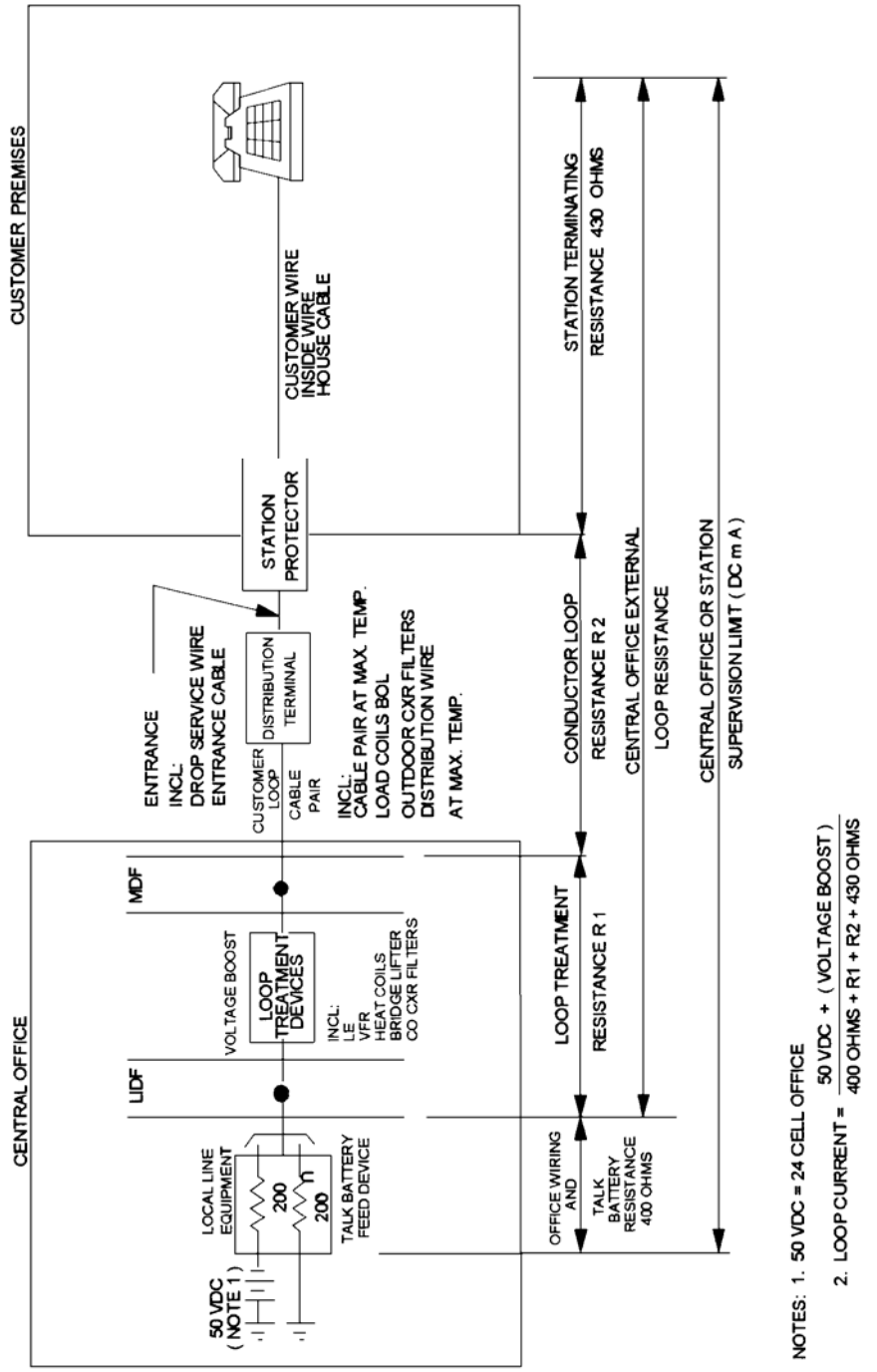


Figure 4 - Loop Current Configuration

(Refer to Paragraph 4.3.2 and 4.3.3)

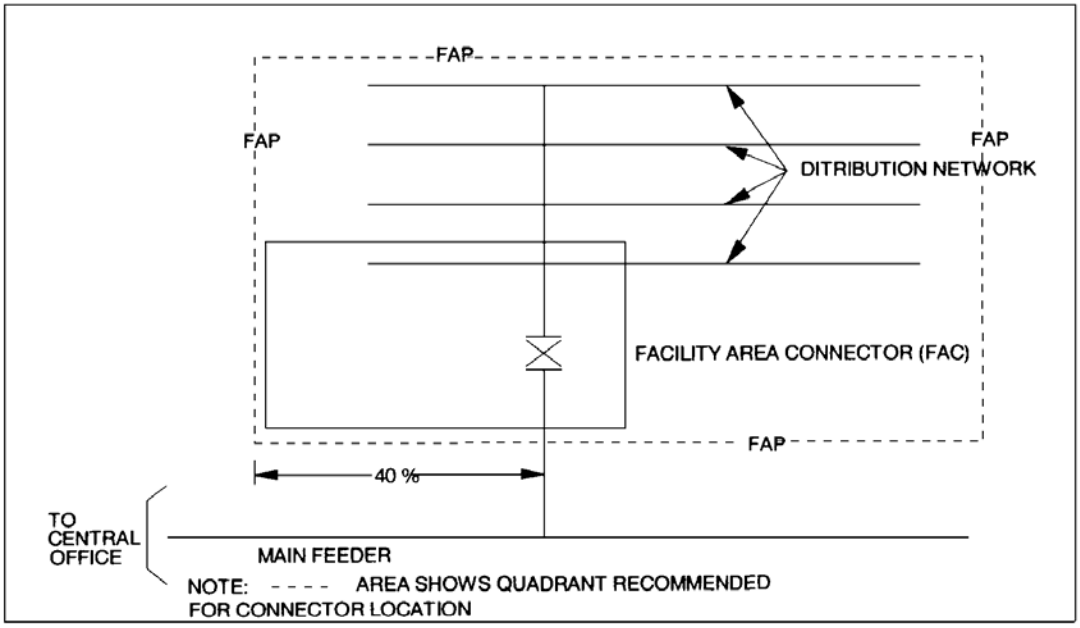


Figure 5 - Location of Connector Streets Parallel to Feeder Cable Route

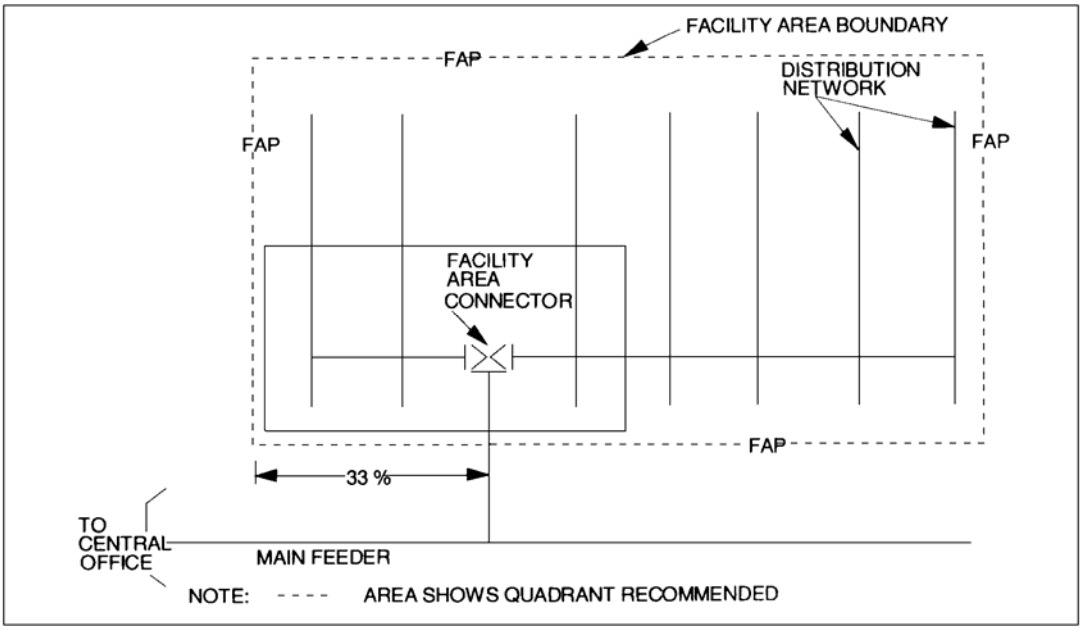


Figure 6 - Location of Connector Streets Perpendicular to Feeder Cable Route

Exhibit 1 - Loop Resistance Limits (Assumes 50 V CO Battery) (See Figure 4)

LOOP LIMITS FOR SAUDI ARAMCO COMMUNICATIONS NETWORK

Central Office Switches

Switch Type	Line type	External Loop Resistance	Loop limit
FETEX-150	Analog line	2100 Ohms	
5ESS	Analog line	1900 Ohms	
DMS-100	Analog line	1900 Ohms	
DMS-100	Digital line		4.5KM of 26 AWG

Premise Switches

PABX switch	Line type	External Loop Resistance	Loop limit
NT Meridian	Analog line	1200 Ohms	
NT Meridian	Digital line	100 Ohms	1.067 KM of 24 AWG

Exhibit 2 - Conductor Loop Resistance Factors

Gauge	Ohms per Kilo foot versus Cable Core Temperature						
(AWG)	20°C (68°F) (1)	43°C (110°F)	49°C (120°F)	60°C (140°F)	65°C (150°F)	71°C (160°F)	77°C (170°F)
26	83.3	91.1	92.9	96.6	98.5	100.3	102.2
24	51.9	56.7	57.9	60.2	61.4	62.5	63.7
22	32.8	35.9	36.6	38.0	38.8	39.5	40.2
19	16.3	17.8	18.2	18.9	19.3	19.6	20.0

Note: (1) For resistance at a temperature (T) other than 68°F, use the following formula:

$$R_T = R_{68} + 0.002222\,(T - 68)\,R_{68}$$

Conversion Formula: °C = $\frac{5}{9}$ (°F - 32)

°F = $\frac{9}{5}$ (°C + 32)