Engineering Standard

11 March 2021

SAES-T-629
Telecommunications Outside Plant (OSP) - Copper Cable

Document Responsibility: Communications Standards Committee

Contents

Summary of Changes

Paragraph Number		Change Type (Addition, Modification, Deletion)	Technical Change(s)
Previous Revision (14 May 2019)	Current Revision (11 March 2021)		
2	2	Modification	Combined section 2.1 and section 2.2
3.1.	3.1	Addition	SAES-J-902 standard
			ANSI/ICEA S-84-608
		Modification	Editorial, BICSI TDMM latest revision – 14th
			Editorial, BICSI OSPDRM latest revision, 6th
4	4	Addition	Aerial Cable definition |(BICSI definition)
		Deletion	PMD definition, this is for fiber optic cable
5	5.1, 5.2, 5.3	Addition	Added sub-sections, to provide clarity to the end users
5.2	5.2	Modification	RCDD stamped requirement is a must during the detailed design phase.
5.4 bullet 3	5.4 Bullet 3	Addition	Add a reference, "Typical trenching (figures) for Rocky Areas and Non-traffic Areas" , alignment with
5.5	5.5	Modification	Editorial, applicable for IT application for copper cable used.
		Addition	Commentary note, to address above ground installation requirements for non-IT cables.
5.6	5.6 Bullet 1, 2, & 3	Addiition	Alignment with the Intenmrational standards requirements and specifications
5.7	5.7	Modification	Required armored cable for offsore applications
6.1	6.1.1	Addition	Typical Copper Cable Transmission Parameters Table
	6.1.2		HDPE pipes requirements and alignment with SAES-T-911
6.2.2	6.2.2	Modification	Alignment with SAES-T-911 address to Pull Rope and Mandrel Testing requirements
6.2.3	6.2.3	Modification and Deletion	Alignment with SAES-T-911 standard and BICSI TDMM requirements address to conduit plug and seals
6.2.4	6.2.4	Modification	Alignment with SAES-T-911 as reference which address conduit systems
6.2.5	6.2.5	Modification	Cable underground installation safety issue shall comply with GI-0002.100, Work Permit Procedures prior to start of work.
6.2.5.4	none	Deletion	Cable underground installation safety issue shall comply with GI-0002.100, Work Permit Procedures prior to start of work.
6.2.5.5	6.2.5.4	Modification	Modified section numbering and referencing GI-0002.100, Work Permit Procedures prior to start of work address to safety.
6.2.6	6.2.6	Modification and Deletion	- Modified section and referencing to GI-0002.100, Work Permit Procedures, and Construction Safety Manual, Volume 1 Contractor Safety Administrative Requirements (CSAR). - Deleted sub-sections address to safety and used specific documents as mentioned above.
6.2.7.1	6.2.7.1	Modification and Deletion	Deleted sub-section address to safety and referencing the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors, with the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors, GI-0002.100, and Work Permit System.
6.2.7.2	6.2.7.2	Modification and Deletion	Deleted sub-section address to safety and referencing the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors, with the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors, GI-0002.100, and Work Permit System.

6.2.7.3	6.2.7.3	Modification and Deletion	Deleted sub-section address to safety and referencing the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors, with the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors, GI-0002.100, and Work Permit System.
6.2.7.3.4	6.2.7.3.1	Modification	- Modified section numbering sequence
6.2.7.3.5	6.2.7.3.2	Modification	Modified section numbering sequence
6.2.7.3.6	6.2.7.3.3	Modification	Modified section numbering sequence and write-up
6.2.13.1 to 6.2.13.3	none	Deletion	Deleted sub-sections and used BICSI TDMM and BICSI OSPDRM standard requirements to comply (alignment with the international standards)
6.3.2	6.3.2	Addition	To comply in with the Government requirements, if involved.
6.3.6	6.3.6	Deletion	Deleted sub-sections and used BICSI TDMM and BICSI OSPDRM standard requirements to comply (alignment with the international standards)
6.3.8.2	6.3.8.2	Modification	Editorial
6.4.2	6.4.2	Modification	Editorial
none	6.5	Addition	Installation Requirements for Temporary Buildings or Structures

1 Scope

This standard covers the mandatory requirements governing the engineering, design, and installation of telecommunications outside plant (OSP) copper cables.

2 Conflicts and Deviations

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

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

3 References

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

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-302	Waiver of a Mandatory Saudi Aramco Engineering Procedure

Saudi Aramco Engineering Standards

SAES-J-902	Electrical Systems for Instrumentation
SAES-T-018	Telecommunications - Symbols, Abbreviations, and Definitions
SAES-T-632	Telecommunications: Splicing Copper Cables, Fiber Optic Cables and Types of Splice Closure
SAES-T-795	Grounding Systems for Communications Facilities
SAES-T-911	Communication Conduit System Design
SAES-T-928	Telecommunications - OSP Buried Cable

Saudi Aramco Standard Drawings

AA-036748	Buried Telephone Cables/Distribution Wires - Installation Details
AB-036897	Buried/Underground Cable Route Marker Post and Signs

Saudi Aramco General Instructions

GI-0002.100 Work Permits

GI-0002.709 Gas Testing Procedure - Using Gas Monitor

GI-1021.000 Street and Road Closure: Excavations, Reinstatements, and Traffic Controls

Safety Management System (SMS)

Saudi Aramco Construction Safety Manual

3.2 Industry Codes and Standards)

Building Industry Consulting Services International

BICSI TDMM Building Industry Consulting Services International, TDMM (Telecommunications Distribution Methods Manual – 14th edition)

BICSI OSPDRM Outside Plant (OSP) Design Reference Manual (OSP DRM – 6th edition)

National Fire Protection Agency

NFPA 70 National Electrical Code (NEC)

International Electrotechnical Commission

IEC-60708 Low-Frequency Cables with Polyolefin Insulation and Moisture Barrier Polyolefin Sheath

Underwriters Laboratories, Inc.

UL 1479 Standard for Safety Fire Tests of Through-Penetration Firestops

UL 94 Standard for Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances Fifth Edition

American National Standards Institute

ANSI/ICEA S-84-608 Standard for Telecommunications Cable Filled, Polyolefin Insulated, copper Conductor Technical Requirements

4 Terminology

4.1 Acronyms

AML: Actual Measured Loss

BOC: Build Out Capacitance

EML: Expected Measured Loss

Hz: Hertz, unit of frequency: on cycle per second

PCM: Pulse Code Modulation

POTS: Plain Old Telephone Service

4.2 Definitions

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

AML: Actual Measured Loss at 1,004 Hz. The measured value of transmission loss, expressed in decibels that include any impairment caused from attenuation, noise and bandwidth restrictions. The actual value is then compared to an objective or calculated value.

Balance: The amount of cancellation of current flowing along tip and ring conductors. Currents that are not cancelled are heard by the subscriber as noise metallic. Balance is in dB and can be calculated by:

Balance = (Noise-to-Ground + 40) - Noise Metallic

or

Balance = Power influence - Circuit Noise

BOC: Build Out Capacitance. This passive device is a capacitor that is bridged between the two conductors of a cable pair and is used to simulate the capacitance of a missing length of cable.

Cable Shield: A metallic layer located under the outer covering of a cable that protects the cable pair. It can be composed of woven, braided, foil wrap, or metal tube that, when bonded and grounded, prevents electromagnetic/electrostatic interference from being induced into the inner wire conductor.

Continuity: The continuity test determines if the tip and ring conductors are continuous.

dBm: dB reference to the milliwatt. dBm is the amount of power relative to that represented by a 1,004 Hz signal which will feed one milliwatt of power into a 600-ohm resistive load.

dBrn: A value of decibels above reference noise that begins at a “O” level dBrn - 90 dB. The measured value describes that power level of a noise as seen through a line weighting network of the test set.

dBrnC: dBrn with C message weighting. dBrnC is measure of the interfering effect of noise expressed as the dB above reference noise of -90 dBm at 1,004 Hz.

EML: Expected Measured Loss - The EML is the 1,004 Hz loss that is expected to be measured between specified test points.

Ground: A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

Insertion Loss: The transmission loss caused by inserting a component or network in a circuit. The ratio of power received at a load before insertion to that received at a load after insertion, expressed in decibels.

Insulation Resistance: The insulation resistance test is taken to ensure that the value of resistance each conductor has to all other conductors in a cable and to the cable shield is a minimum of 1,000 megohm-miles.

Loaded Loop: A loop into which lumped inductance (loading coil) is introduced at fixed intervals to compensate for the distributed cable capacitance. The addition of loading coils properly placed, reduces mid-voice band loss, and flattens the frequency response over most of the voice band, but creates a sharp cut-off at the high-frequency band edge.

Loop Resistance: The actual DC resistance of the circuit.

Noise Metallic (Differential Noise): The noise measured across the tip and ring of a circuit; the noise the subscriber hears.

Noise-to-Ground (Common Mode Noise): A measure of the power influence on the cable conductors whose magnitude is a function of the power line current and voltage present at particular harmonic frequencies. Although the subscriber cannot hear noise-to-ground, its magnitude determines the level of noise metallic that is heard, Noise to Ground = Power Influence - 40 dB.

Power Influence: The characteristics of power circuits and associated apparatus that determine the character and intensity of the fields they produce.

Resistance Unbalance: A measurement of the equality of the dc resistance of the tip-to-ground versus the ring-to-ground with the pair grounded at the far end.

Shield Continuity: Verifies the cable shield continuity for the entire length of cables being tested.

5. General Requirements

5.1 OSP Design Reference

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

5.1.2 Saudi Aramco standard drawings (SASD) and library drawings shall be used to complement to this standard.

5.1.3 The industry standards listed in Section 3 of this standard shall be used for additional information such as definitions, abbreviations and explanation for further clarifications.

5.2 OSP Designer Certification Requirements

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

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

5.3 Design Documentation

As a part of each telecommunications work order/project, detail schematic drawings shall be prepared for each copper cable span

5.3.1 Copper cable data:

5.3.1.1 Cable manufacturer

a) Vendor number
b) Cable size (number of pairs)
c) Cable type (filled or air core)
d) Cable design (single jacket, inner/ outer jackets, aluminum shield, solid insulation, foam skin insulation, steel armor, etc.)
e) Pairs wire gauge

5.3.1.2 Other information:

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

5.4 Design Drawings Classification

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

5.4.1 Cable Drawing (Cable Schematic):

5.4.1.1 Cable layout shall have all the complete information symbolizing installation, removal or rearrangement of copper cable, terminating equipment and other equipment associated with the copper cable. It shall also include address or location of the cable route and terminal.

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

5.4.1.3 Cable shall be properly identified using applicable Saudi Aramco copper cable designation symbols as specified in SAES-T-018.

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

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

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

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

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

5.4.2.2 Trench section detail, maintenance hole layout and other detail drawings shall be shown in the section for "Detail Drawings".

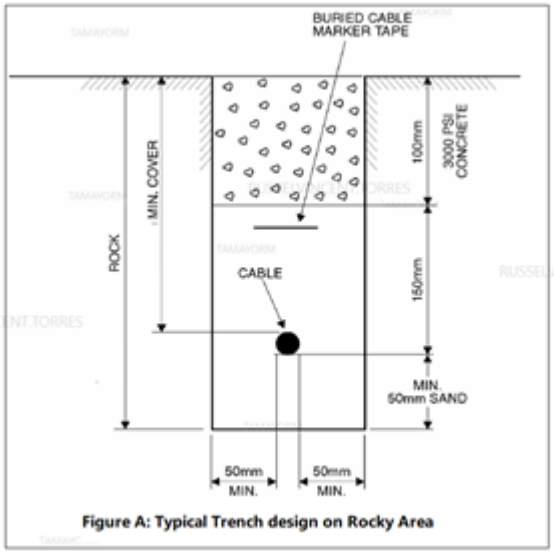

Figure A: Typical Trench design on Rocky Area

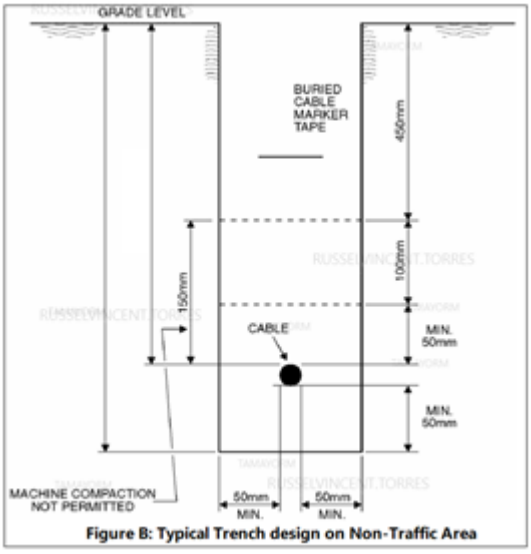

Figure B: Typical Trench design on Non-Traffic Area

5.4.3 Detail Drawings (Detail Schematic):

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

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

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

5.5 Cable Route

The cable route for all new communication copper cables shall be reviewed by the stakeholders e.g. AREA-IT, ITED, and Plant facilities. The approved Company construction or installation methods are as follows;

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

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

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

Commentary Note:

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

5.6 Cable Characteristics

All Saudi Aramco OSP copper cables for underground or direct buried installation shall be of filled core type. The cable material shall comply with;

1) ANSI/ICEA S-84-608: For electrical and mechanical characteristic requirements for filled, Polyolefin insulated, copper conductor cable.
2) IEC-60708: For mechanical, electrical and environmental characteristics for all types of low-frequency cables with polyolefin insulation (solid or cellular), filled or unfilled, and moisture barrier polyolefin sheath (with integral suspension strand).
3) ANSI/ICEA S-84-608: For Telecommunications Cable Filled, Polyolefin Insulated, copper Conductor Technical Requirement

5.7 Metallic Armor Use

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

5.8 Composite Cable Use

Outside plant composite cable shall not be used.

5.9 Pulling Tension

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

5.10 Cable Environment

All environmental conditions (petroleum, petroleum-based products, thermal, chemical, mechanical, electrical conditions, etc.), which could be detrimental to the cable when it is installed, shall be identified and all necessary action taken to

protect the cable from the potential hazards in its environment. Cable Environment

6. Design

6.1 Cable Design

6.1.1 OSP cable shall be sized (number of pairs in the cable) to meet the maximum expected requirements. Conductor gauge and cable length shall be specified based on the calculation of user loop requirements and cable limiting characteristics, such as, loop resistance, capacitance, attenuation loss, computed attenuation loss and computed conductor loop resistance of the specified cable. The transmission parameters table is required, see below.

Typical Coper Cable Transmission Parameter Table

Cable ID	Copper Cable Section		Cable Gauge (mm / AWG)	Length (m)	Attenuation Loss @ 1000 Hz			Loop Resistance Loss @ 1000 Hz			Computed Attenuation Loss (dB)	Computed Conductor Loop Resistance (ohms)
	From	To			TBD (dB/Km)	TBD (dB/Km)	TBD (dB/Km)	TBD (ohms/Km)	TBD (ohms/Km)	TBD (ohms/Km)		

NOTE:
(1) TBA: To be defined during the project phase.
(2) Length shall be in SI unit (meters).
(3) Gauge shall be in (mm)/(AWG).

6.1.2 For non-metallic materials:

High Density Polyethylene (HDPE) corrugated pipes with a built-in sub duct is used for the underground infrastructure to host copper cable. The sizing (number of pairs in the copper cable) shall meet the sub duct size requirements as stated in SAES-T-911 standard such as, a 4-sub ducts or 3-sub ducts formations.

6.2 Underground Cable Engineering

6.2.1 This section prescribes the engineering and design of telecommunications copper cables for the plant facilities and installing telecommunications conduit system. It is assumed that the conduit system is complete and has been designed, constructed, and tested in accordance with SAES-T-911.

6.2.2 This section prescribes the engineering and design of telecommunications copper cables for the plant facilities and installing telecommunications conduit

6.2.2.1 Pull Rope Requirements

For Pull rope requirements, it shall comply with SAES-T-911 standard.

Commentary Note:

1) All fish line ropes which are placed for future use shall be of non-biodegradable materials.
2) In all cases, where cable is to be placed in main conduit, thoroughly clean the ducts before the pull line or cable is placed.
3) Service laterals, which are old or which are suspected of being cluttered with sand or debris, must be thoroughly cleaned before cable is placed.

6.2.2.2 Mandrel Testing

6.2.2.2.1 For HDPE pipes, with solid wall type, it shall follow SAES-T-911 requirements.

6.2.2.2.2 For HDPE pipes, with solid wall type, it shall follow SAES-T-911 requirements.

6.2.3 Underground Cable and Sealing Conduit - Installation and Removal

For conduit plug and seals, comply with SAES-T-911 standard and BICSI TDMM requirements.

Commentary Note:

1) Whenever work extends overnight, a plug must be installed into the conduit until work resumes.
2) The intent of this standard is to ensure that the underground spaces (MH, cable vault, HH) and conduit system seals are maintained and safety hazards are highlighted and corrected. When an existing maintenance hole and conduit system is found to have seals damaged or missing, a report identifying each seal (maintenance hole no. and duct no., location) is to be issued promptly to the responsible maintenance and Operations agency so that immediate action can be taken to make repairs of these seals. The exception to this is when a project job order specifically calls for the repair of damaged seals in the scope of work and construction drawing.

6.2.3.1 Refer to below Table 1, to determine which type of conduit plug is appropriate to use under specific conditions.

Table 1 - Conduit Plug Types Guidelines

Condition	Seal With
Conduits entering Central Office (CO) cable vaults, Controlled Environmental Vaults (CEVs), and other buildings e.g. main TER, central control buildings.	• Blank conduit plugs for unoccupied vacant conduits. • Simplex conduit plugs for sealing a single copper cable or fiber optic cable. • Triplex or Quadplex plugs for sealing multiple cables or innerducts within a conduit.

Condition	Seal With
Conduits for (drop) wire and small entrance cables to buildings at maintenance hole (if it is impractical to seal the conduit in the building).	Split conduit plugs, simplex, triplex, or quadplex.
Ducts containing cable or innerduct that are terminated on poles or building walls.	Split conduit plugs.
Ducts terminating on poles or building walls mat are for unoccupied riser conduit.	Blank duct plugs with Hex nuts.
• Conduits entering or leaving maintenance hole. OR • Pull boxes whim contain electrical apparatus *such* as Pulse Code Modulation (PCM) carrier housings, etc.	• Split conduit plugs for conduit containing cable. • Blank plugs for unoccupied duct/innerduct, etc.
Conduit not connected to conduit system, such as: • Steel pipe clips under structures. • Submarine pipe crossings. • Between poles to buildings. • And similar construction.	• Split conduit plugs at both ends for occupied ducts with cable or innerduct. • Blank plugs at both ends for unoccupied ducts.

NOTE: Conduit plugs may be wed to seal riser conduit or other openings between cable vaults or other building areas. Cable plugs help support cables as the cables transit vertically between floors or horizontally between walk.

6.2.3.2 Additional Requirements for Conduit Plugs

6.2.3.2.1 All dirt, grease, and loosely adhering materials must be removed from the conduit and the plug before installing duct plugs.

6.2.3.2.2 Addition - Rubber conduit plugs and sealing compound which are not fire retardant, then it must not be used to seal cable riser or other openings between cable vaults and switch rooms or in other building areas except at the conduit building entrance.

6.2.3.2.3 Rubber duct plugs are not acceptable for sealing conduits that pass through classified or hazardous areas [Refer to (NFPA 70) NEC Articles 500 & 501].

6.2.3.2.4 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.

6.2.3.2.5 For UL Classified Firestop Sealant, Fire Barrier Caulk, and Putty or equivalent are acceptable as fire retardant sealants for use inside the buildings. All fire sealants used inside building (except at the building conduit entrance

from the outside) must be listed as complying with UL 1479.

6.2.4 Cable Underground Conduit Sealing Compound Types

The two-part polyurethane duct sealant or a duct sealing compound type with UL listed (or equivalent) is acceptable in an underground conduit duct sealant. For additional requirements, refer to SAES-T-911 and SAES-T-928 standard.

6.2.5 This section Cable Underground Installation Precautions

This section provides safety precautions, which must be taken when working in the underground maintenance hole/vault for non-ventilated types. Also, it shall comply with GI-0002.100, Work Permit Procedures prior to start of work.

6.2.5.1 Protection of Maintenance Hole

Always protect open maintenance hole with standard manhole guards. For the road construction safety, such as, traffic control barriers, lights, hazard warning devices, construction & road signs, flagmen, excavations, road closure/crossing. Refer to Saudi Aramco Construction Safety Manual, Construction Safety Manual, Part II Civil, chapter 11 and GI-1021.000

6.2.5.2 Protection of Cables

Care shall be taken to prevent damage to existing cables in maintenance hole when setting up the pulling apparatus or placing tools of any kind. Do not step on cables or rack hooks when entering or leaving a maintenance hole; always use an approved ladder.

6.2.5.3 Warning Devices on Cable Reels

General requirements for traffic control barriers, lights, Hazard warning devices, and etc. shall comply with Saudi Aramco Construction Safety Manual, Part II Civil, chapter 11 – Road Works and GI-1021.000.

6.2.6 Underground Cable Open Flames and Arc Producing Devices in Maintenance hole Procedures

Any activity that may develop sparks, flames or heat sufficient to cause ignition shall comply with GI-0002.100, Work Permit Procedures.

In addition, PPE's such as hard hats, safety shoes, and approved eye protection are mandatory and shall comply with the Construction Safety Manual, Volume 1 Contractor Safety Administrative Requirements (CSAR).

6.2.7 Underground Maintenance Hole and Cable Vaults Testing and Ventilating Procedures

This section describes procedures for testing for the presence of combustible and toxic gas in manholes, unvented cable vaults, and buildings that have underground cable entrances and continuous manhole ventilation by means of power blowers.

6.2.7.1 Every maintenance hole or unvented cable vault to be opened or reopened after having been closed for any period of time shall be tested for combustible and toxic gas, and the following standard shall be adhered;

1) For atmospheric gas testing of hazardous gases inside a confined space e.g. maintenance hole, cable vaults, shall be in accordance with the Saudi Aramco Construction Safety Manual and GI-0002.709- Use of Portable Gas Monitors.

2) For Road Works, it shall follow the Construction Safety Manual, Part II Civil, chapter 11, and GI-1021.000 for Road Closure/Crossing: Excavation , Reinstatement and Traffic controls.

3) For Work Permits, it shall follow GI-0002.100, Work Permit System.

4) For Gas testing equipment, is shall be in accordance GI.002.709-Gas Testing Procedure and Saudi Aramco Construction Safety Manual.

Commentary Note:

When plugged Cable Ducts are opened, additional tests for combustible gas must be made near the ducts to verify that combustible gas is not entering the maintenance hole.

6.2.7.2 Safety Precautions

Maintenance hole/Vault shall not be entered until they have been thoroughly tested and proven safe for entry in accordance with GI-0002.709, and ventilated with fresh air from a maintenance hole blower for a minimum purge time (see Table 2).

All electrical switching connections and disconnections must be made outside a maintenance hole, at least 3 meters from the maintenance hole opening

6.2.7.3 Ventilating Maintenance Hole

6.2.7.3.1 Ventilation Set Up

Continuous forced-draft ventilation with a minimum of 14.1 cubic meters per minute must continue as long as the maintenance hole is open.

WARNING:

If the blower stops, the maintenance hole shall be vacated at once and the blower hose shall be removed from the maintenance hole. When the blower is reactivated, the blower hose shall be purged, prior to placing it back into the maintenance hole.

6.2.7.3.2 Upon entering the maintenance hole, arrange the outlet end of the blower hose on the cable rack to direct the flow of air horizontally, midway between the maintenance hole floor and roof toward an end wall and away from the work area if possible.

Table 2 – Maintenance Hole (MH) Ventilation Chart

Effective Blower Capacity Cubic Feet (Meter) Per Minute							
MH Volume							
Cubic Feet		**500**	**600**	**700**	**800**	**900**	**1,000**
(Cubic Meter)		**(14.1)**	**(17.0)**	**(19.8)**	**(22.6)**	**(25.5)**	**(28.3)**
100	(2.8)	5	5	5	5	5	5
200	(5.7)	5	5	5	5	5	5
300	(8.5)	5	5	5	5	5	5
400	(11.5)	6	5	5	5	5	5
500	(11.5)	8	7	6	5	5	5
600	(14.1)	10	8	7	6	5	5
700	(19.8)	11	9	8	7	6	5
800	(22.6)	13	10	9	8	7	6
900	(25.5)	14	11	10	9	8	7
1,000	(28.3)	15	12	11	10	9	8

6.2.7.3.3 Testing and Ventilating Cable Vaults and Unattended Telephone Equipment Buildings for Gas

Cable vaults, which do not have natural or mechanical ventilation and unattended building with an underground cable entrance must also be proven safe prior to entry or beginning work operation, in accordance with GI-0002.709.

6.2.8 Cable Underground Placing in Main Conduit

This section outlines the procedures for placing cables in conduits between maintenance hole.

6.2.8.1 Loading Cable Reel

In most instances, the cable reel should be loaded so that the cable may be fed from the top of it. In every instance caution must be exercised so that reverse cable bending is not encountered when placing the cable in the underground conduit system.

6.2.8.2 Positioning Equipment at the Job

6.2.8.2.1 Whenever possible, locate the trailer on the side of the maintenance hole nearest the conduit section in which the cable is to be placed. Position the trailer so the cable is fed from the top of the reel, in a long arc, into the cable feeder and duct.

WARNING:

Whenever a cable trailer is released from a truck, the prescribed safety chain shall be left attached to the truck and the trailer until the tongue of the trailer is placed on the ground. The truck shall be located so that exhaust fumes will not enter the maintenance hole.

6.2.8.2.2 Always use safety blocks under the trailer's wheels when it is detached from the truck. Whenever it is necessary to place trailers on sidewalks or other areas not capable of supporting them, place planking under the trailer wheels and tongue to prevent surface damage.

6.2.8.3 Placing the Cable

6.2.8.3.1 Lubricate the first 6 m (20 feet) of cable to reduce initial duct friction. The amount of the lubricant required during the remainder of the pull should be determined by the conditions being encountered. Bends, long pulls, pulling through maintenance hole, etc., may require more lubricant.

6.2.8.3.2 Pull cable slowly until at least 610 mm (2 feet) of it has entered the duct. This may be determined by measuring the distance from the duct face to the top of the cable feeder, plus 610 mm (2 feet). An equal distance should then be measured from the end of the cable and marked with vinyl tape. When the tape marking reaches the funnel of the cable feeder, the required two feet of cable are in the duct. From this point, the cable may be pulled, steadily and continuously, at the rate of 24m to 30 m per minute.

6.2.8.3.3 When the cable has been pulled to within 6 meters of the maintenance hole, as determined by the quantity of cable remaining on the reel, the pulling speed should be reduced. Continue pulling the cable at the reduced speed until the swivel link is 150 mm from the sheave located in the maintenance hole.

6.2.8.3.4 If it is necessary to stop the cable between maintenance hole, because of reel trouble or other reasons, the tension on the winch line should be maintained unless the operator is asked to release the line tension. When continuing the pull, the speed must be increased gradually until the cable moves freely.

6.2.8.3.5 An approved luffing grip must be used to pull the additional specified quantity of cable into the maintenance hole.

WARNING:

Workmen shall not remain in the manhole during the luffing operation pulls unless so directed by the supervisor.

6.2.8.3.6 The cable ends in the maintenance hole shall be cleaned and placed on maintenance hole hooks or tied to the racks with lashing wire.

Commentary Note:

Avoid unnecessary bending of the cables in attaching them to cable hooks or racks. All cable bend radii shall be 10 times the cable diameter or greater.

6.2.9 Cable Guards - at Riser Poles and Buildings Installation

This section provides instructions for:

1) Placing guards at riser poles and buildings
2) Clamping cable to riser poles.

6.2.9.1 Placing U-Cable Guard

6.2.9.1.1 Install U-Cable guards to protect cables which are leaving underground conduit systems or direct-buried at poles and buildings.

If installation is Required	Then install a(n)
Immediately above a conduit	2.50-meter (8') Guard.
In sites without a conduit	2.74-meter (9') Guard (One foot must be buried below the ground).

6.2.9.1.2 A minimum of two U-cable guard straps shall be placed on each U-cable guard. One strap shall be located 150 mm below the top of the U-cable guard and one 150 mm above the earth surface or the end of the conduit pipe bend. The cable shall be clamped to the pole or building at 600 mm intervals with the first clamp being placed 125 mm above the top of the U-cable guard.

6.2.10 Placing Underground Cable in Subsidiary Conduit

This practice covers the placing of cable in subsidiary conduit, that is, from a maintenance hole to a pole for building or between poles in an isolated dip.

6.2.10.1 Setting-up Equipment

6.2.10.1.1 When cable is to be placed in a duct which extends from a maintenance hole to a pole or to a building wall, it is preferable to set up the cable reel at the end of the duct nearest the bend so that the cable can be fed from the reel into the duct in a long smooth arc.

6.2.10.1.2 Cable can usually be placed in subsidiary ducts with only one 90 degrees bend and less than 46 meters in length, without the use of lubricant. If the duct length exceeds 46 meters or if it contains the equivalent of more than one 90-degree bend, use an approved cable lubricant.

6.2.10.1.3 Leave a sufficient cable slack at each end of the duct to permit setting up and splicing. Secure the cable to the pole, up to the strand level, with cable straps, leaving sufficient cable at the strand level to make the splice. If a short piece of fuse cable is to be placed at the pole, it is only necessary to leave enough cable to reach to the strand level, since the first splice out of the underground will be made a minimum of 600 mm below the strand level.

6.2.11 Splicing Arrangements in Maintenance holes

This section outlines splicing arrangement in maintenance hole.

6.2.11.1 Installation Principles

When racking cables in maintenance hole:

1) Changes in cable level must be kept to a minimum.
2) It shall be carefully determined that racking of a given cable in the proposed manner will not block or restrict the use of any vacant duct or racking position.
3) When bending cables, make the radius of the bend as large as possible. The radius of the bend must be a minimum of 10 times the diameter of the cable.

6.2.11.2 Racking Space

6.2.11.2.1 A minimum space of 385 mm shall be maintained in all maintenance hole between the roof of the maintenance hole and the center of the top main cable for racking stub and lateral cables.

6.2.11.2.2 A minimum space of 385 mm shall be maintained between the maintenance hole floor and the center of the bottom main cable.

6.2.11.2.3 The vertical spacing of splices shown in Table 3 should be observed where either single or double racking is employed.

Table 3 - Vertical Spacing of Splices

Staggered Splices	195 mm
Non-staggered Splices	230 mm

6.2.11.2.4 Hook hole positions in all maintenance hole number from the top of the cable rack down (refer to SAES-T-911).

6.2.11.2.5 Ducts Entering at Different Levels

Where the main conduit structures enter the maintenance hole at different levels, the cable racks, and cables should be so arranged that an equal amount of the required bending will be done at each end.

6.2.11.2.6 Difference in Number of Ducts

When two main conduit structures having different numbers of ducts enter a maintenance hole, the racking positions in the maintenance hole must be based on the structure with the largest number of ducts.

6.2.11.2.7 Cable Hooks

The cable and the completed splice shall be supported with cable hooks at each cable rack.

6.2.11.2.8 Splice Closure

Where distance between cable racks is such that it appears that sagging might occur, the splice should be secured to a piece of pipe or other support material laid across the cable hooks. Secure the closure tightly to the pipe with lashed cable supports.

6.2.12 Cable Underground Removal

This section outlines procedures for removal of underground cable.

6.2.12.1 Cutting Cables

Underground cable that is to be removed will generally be cut out of service by the Saudi Aramco telecommunications proponent splicing forces. However, in certain cases, such as where several consecutive sections are involved, the

PMT forces may be called upon to cut the cable in the intermediate maintenance hole. In these cases, the cable must be carefully identified before cutting, to ensure that a working cable is not cut.

6.2.12.2 Precautions

6.2.12.2.1 Before starting any pulling operations, the work area must be guarded with the appropriate warning devices as outlined in Saudi Aramco Construction Safety Manual. Testing of maintenance hole atmosphere must also be done prior to entering the maintenance hole (see Section 6.2.7 above).

6.2.12.2.2 A cable which has been in a duct for some time may require considerably more force to break loose than will be required to keep it in motion. Because of the severe strains which may be placed in the winch line, no workman will be permitted in the maintenance hole when the initial pull is made or at any other time when the winch appears to be heavily loaded.

6.2.12.2.3 When the cable removing apparatus has been set up and the grip has been placed on the cable, a slight tension should be pulled in the line to determine whether the grip will remain in place. Before full tension is applied, the workmen must leave the maintenance hole. He should be in the maintenance hole during the puling operation only if it is essential to the performance of the work and it is apparent that the tension in the winch line is normal. If the cable pulls in a succession of sharp jerks, there is a possibility of the line breaking, and no workman should be in the maintenance hole.

6.2.12.2.4 When a workman is in a maintenance hole, he must be the originator of the starting and stopping signals.

6.2.12.3 Removing Subsidiary Cable

Subsidiary cable should generally be removed at the maintenance hole end to reduce the strain on the riser bend.

6.2.13 Bonded ASP Cable Installation Underground Placing/Splicing

This section provides Outside Plant Engineering placing and splicing procedures unique to bonded ASP cable, and it shall comply with BICSI OSPDRM standard requirements in all aspects.

6.3 Direct Buried Cable Engineering

6.3.1 Direct buried telecommunication cables shall be placed at minimum depths in accordance with SAES-T-928.

6.3.2 Buried cable crossings of streets, roads, and highways shall comply with SAES-T-928, and in accordance with any Government requirements when Government roads are involved.

6.3.3 Road and railroad crossings shall be constructed in accordance with SAES-T-911, SAES-T-928, and in accordance with any Government requirements when Government roads are involved.

6.3.4 Telecommunication cables which are placed in the vicinity of power facilities shall be installed in accordance with SAES-T-928.

6.3.5 Joint Buried Cable

6.3.5.1 The “Random Separation” joint trench method shall not be used in Saudi Aramco for joint trench construction with power facilities. Joint buried construction with power facilities requires fixed separation as indicated above and in SAES-T-928.

6.3.5.2 Joint pedestals for power and telecommunication cables shall not be used. Telecommunication terminal housings/pedestals located within 3 m (10') of power apparatus (transformer / pedestals, etc.), or vertical pole grounds (MGN) shall have their grounding systems bonded together. Refer to SAES-T-795.

6.3.5.3 All excavations and restorations shall be carried out in accordance with the Saudi Aramco “Safety Management System (SMS).”

6.3.5.4 Electrical protection requirements shall be installed in accordance with SAES-T-795.

6.3.6 Optimized Direct Buried Cable Delivery System

This section is intended, primarily, as a guide to be used when ordering or purchasing cable plowing equipment; however, the following are mandatory requirements when telecommunication cables are to place by the plowing-in method. The requirements stated in the BISCI OSPDRM and BICSI TDMM shall be followed.

6.3.7 Buried Cable Signs - Description and Installation

Saudi Aramco Drawing AB-036897, “Buried/Underground Cable Route Marker Post and Signs”, provides typical installation information. Marker post/sign locations shall be shown on the construction drawings. Marker/Identification tape shall be placed in accordance with SAES-T-928.

6.3.8 Joint Buried Cable - Maintenance/Emergency Safety Precautions

Existing communications facilities shall always be exposed by hand digging. Hand digging tools utilized shall have handles made of wood or other material having comparable insulating value. If power cables are to be exposed, Proponent should be on site prior to or during the excavation to advice as appropriate. Insulated rubber gloves, suitably certified, shall be worn while digging and while examining the markings and outside structure of the cables during the visual inspection of excavated cables.

6.3.8.1 After identifying the proper telecommunication cable and before breaking the cable metallic shield, a temporary bond shall be placed across the area to be opened to minimize difference in electrical potentials.

6.3.8.2 Telecommunications personnel shall not move or bend power cables at any time. The Proponent must be requested to identify and reposition power cable as necessary.

6.4 Cable Splicing and Termination

6.4.1 Splicing of the cable closure selection shall be in accordance with SAES-T-632.

6.4.2 Never run more than 15 m (50 ft) of non-fire rated OSP cable in entrance facilities (EF) within a building. A transition splice point from outside plant non-fire rated to indoor fire rated cable shall be made to limit the exposed non-fire rated cable to 15 m or less.

6.4.3 OSP cables shall be spliced to fuse cable two gauges smaller when terminated inside building entrance room.

6.4.4 All exposed telecommunication cable conductors that enter buildings shall be protected with UL-listed protectors' terminal. Solid state protector's terminal is preferred; however, other types of protectors are acceptable. The protected terminal shall be installed immediately adjacent to the exposed cable point of entry. (Refer to SAES-T-795 for Grounding, Bonding and Electrical Protection for Telecommunications Facilities).

6.4.5 Only appropriate solvent shall be used when preparing the cable for splicing. Petrochemical materials used as fuel (such as Kerosene or Gasoline) shall not be used for cleaning the cables.

6.5 Temporary Buildings or Structures Consideration

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

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

Commentary Note:

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

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

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

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

6.5.3 All OSP copper cable shall be terminated in a secure OSP rated splice closure.

7 Installation

7.1 During construction, cables shall be protected from being driven over by highway traffic, construction equipment and other vehicles, and from any other activity that might damage the cable.

7.2 All conduit ends must be sealed and plugged after completed the cable installation.

8. Testing and Inspection

The testing and acceptance of installed copper telecommunication OSP cables shall be done in accordance below requirements, as follows:

8.1 Acceptance Testing – Cable Facility

8.1.1 Acceptance tests shall be performed on all new cables, additions or re-arrangements to existing cables when:

8.1.1.1 Adding 305 meters or more of cable.

8.1.1.2 Altering the attenuation loss of a voice frequency circuit (loaded or non-loaded) by more than -0.5 dB at 1,004 Hz.

8.1.2 On-reel acceptance tests at least 80% shall be performed on the cable to confirm the manufacturer's tests before the placing operation begins.

8.1.3 For every pair with an irregularity, two or more pairs in the same complement shall be checked.

8.1.3.1 If one or both pairs show irregularities; then, all pairs in the complement shall be checked.

8.1.3.2 If 25% or more of the tested pairs show irregularities; then, all pairs of the cable shall be tested.

Exception:

If all irregular pairs are confined to one complement, test only the pairs in that complement.

8.2 Responsibilities

Engineering shall be responsible for:

8.2.1 Providing cable schematics showing:

- Test points
- Loading points
- Loop loss at 1,000 Hz
- Loop resistance

8.2.2 Identifying all special testing requirements.

8.2.3 Providing estimated measured loss for E1 Repeater sections.

8.2.4 Providing calculated resistance for E1 Repeater sections.

8.3 Outside Plant Construction shall be responsible for:

8.3.1 Performing the cable acceptance testing on all cables in accordance with:

Commentary Note:

This SAES and any other tests specified on the work order by Engineering.

8.3.2 Ensuring that 100% of constructed facilities meet Saudi Aramco mandatory requirements for the type of facility being tested.

8.3.3 Testing facility extensions from terminated point to terminated point.

8.3.4 Reporting cable troubles identified while testing in existing cables to the Communications Operations and Maintenance Department.

8.3.5 Repairing any trouble detected during cable acceptance testing in the new facilities.

8.4 Cable Facility Acceptance Test (FAT) Requirements

Before a cable is designated for voice frequency (VF) or E1 digital transmission, standard cable acceptance testing procedures shall be completed to verify DC and high frequency acceptability.

Commentary Note:

All cable acceptance tests from the central office must be performed from the cable side of the central office protector to the distribution terminal.

8.4.1 All cable pairs, including POTS, (Loaded & Unloaded), Special Service, and E1 digital on cable, shall meet the minimum acceptance test requirements listed in Table 4.

Table 4 - Typical Testing Method

Test	Requirement
Continuity and Polarity	Continuity test shall be made on all pairs for shorts, grounds, and opens. Shorts, grounds, and opens in all new cables shall be corrected; pairs shall be properly grounded. Continuity troubles identified in the existing cables tested shall be reported to the Saudi Aramco Communications Operations and Maintenance Department.
AC Longitudinal Induced Voltage	AC longitudinal voltage shall be a maximum of 10 volt (rms)
Insertion Loss (Frequency Run)	Insertion loss shall be computed and measured over (Frequency Run) the frequency band from 500 Hz to 2,500 Hz. The 1 kHz-measured loss shall be within plus pair or minus 0.5 dB of the calculated loss value. A maximum loss of 8.5 dB (at 1 kHz) shall be acceptable.
Insertion Loss (Frequency Run)	For non-loaded cable, the measured loss at 2,500 Hz shall be within 6 dB of the measured 1 kHz loss. For H88 loaded cable, the loss over the frequency band from 500 Hz to 2,500 Hz shall be flat and be within: • Plus or minus 0.5 dB for up to four load points. • Plus or minus 1.5 dB for more than four load points.
Insulation Resistance (For POTS Service, 1 pair shall be tested in 25 pair group. For Special Services and Digital Systems, 100% of pairs shall be tested).	Insulation resistance shall be a minimum of 1,000 meg-ohm miles at a potential of 500 volts for one minute measured at increments of 6,000 feet or less.
Loop Resistance (100% of pairs shall be tested).	Loop resistance shall measure within plus or minus 10% of the actual calculated value, and all sample pairs shall measure within plus or minus 2% of the average.
Noise Metallic (For POTS Service, 1 pair shall be tested in 25 pair group. For Special Services, 100% of pairs shall be tested).	Circuit noise measurement shall not exceed 20 dBrnC.
Power Influence (For POTS Service, 1 pair shall be tested in 25 pair group. For Special Services, 100% of pairs shall be tested).	Power influence shall not exceed 80 dBrnC.
Resistance Unbalance (100% of vacant pairs shall be tested).	Resistance unbalance of exchange pairs shall not exceed 10 ohms.
Shield Continuity (100% of cable shield shall be tested).	Shield shall be continuous.

8.4.2 All POTs on loaded cable pairs only, shall meet the minimum Structural return loss test requirements listed in Table 5.

Table 5 - Structural Return Loss Test

Test	Requirement
Structural Return Loss (For POTS Service, 1 pair shall be tested in 25 pair group. For Special Services, 100% of pairs shall be tested).	19-gauge LC 23.0 dB 19-gauge HC 23.4 dB 22-gauge 25.6 dB 24-gauge 26.8 dB 26-gauge 28.1 dB LC = Low Capacitance HC = High Capacitance All facilities assume H-88 loading

8.4.3 All cable pairs on screened and/or non-screened cable used for E1 shall meet the minimum acceptance test requirements listed in Table 6.

Table 6 - E1 Acceptance Test Requirements

Test	Requirement
Resistance Unbalance (100% of pairs shall be tested)	Resistance unbalance shall not exceed 3 ohms or 0.5% of the loop resistance, whichever is greater.
AC Longitudinal Induced Voltage	AC longitudinal voltage shall be a maximum of 10 volt (rms)
Insertion Loss @ 772 kHz (100% of pairs shall be tested)	Measured loss with an all 1s signal must not exceed the calculated maximum loss by more than 2.5 dB of the loss at 772 kHz for T1. Considering each direction separately, the range of losses among all pairs measured must not exceed 3.5 dB at 772 kHz for T1.
Signal-to-Noise (T1 non-screened cable only)	The noise variance shall represent the difference between the reference and the measured readings using the Sierra 413 or equivalent equipment. Facility e/w Capacity — S/N Margin — Noise Variance 0 — 8 dB minimum — <1 </=49 — 4 dB minimum — <2 50-80 — 4 dB minimum — <2 >/=81 — 4 dB minimum — <2

8.5 Test Equipment

Provide a proof of certificate of calibration for all test equipment, this to ensure it have been periodically calibrated and certified by either the Original Equipment Manufacturer (such as an authorized manufacturer third party commercial service center), a third-party commercial calibration laboratory duly accredited internationally or a third-party commercial calibration laboratory certified nationally by the Saudi Arabian Standards Organization (SASO).

8.6 Testing Procedures

Cable testing shall be done as outlined in Table 7.

Table 7 - Cable Testing Procedure

Test	Activity
Continuity and Polarity	1. Place the ground on the tip side of the pair at the far end. 2. Measure the dc resistance between the tip and ground. 3. Place a ground on the ring side of the pair at the far end. 4. Measure the dc resistance between the ring and ground.
AC Longitudinal Induced Voltage	1. Place the ground on the tip side of the pair at the far end. 2. Measure the AC voltage between the tip and ground. 3. Place a ground on the ring side of the pair at the far end. 4. Measure the AC voltage between the ring and ground.
Resistance Unbalance	1. Clear the ends of all conductors on the far end (opposite the tested end). 2. Remove all protective devices from test pairs. 3. Bunch and ground all conductors on the testing end. 4. Remove one conductor at a time and measure that conductor to the bunched and grounded conductors. 5. After a conductor is tested, return it to the bunched group and select another conductor for testing.
DC Loop Resistance	1. Place a short on the pair at the far end. 2. Measure the dc resistance across the tip and ring.
Resistance Unbalance	1. Ground the ring side of the cable pair at the far end. 2. Read the ring-to-ground value. 3. Ground the tip side of the cable pair at the far end. 4. Read the tip-to-ground value.
Shield Continuity	1. Bunch and ground cable pairs of the cable being tested at the near and far ends. 2. Make a power influence reading. 3. Compare this reading to the power influence reading made during the noise measurements.
Continuity and Polarity	1. Place the ground on the tip side of the pair at the far end. 2. Measure the dc resistance between the tip and ground. 3. Place a ground on the ring side of the pair at the far end. 4. Measure the dc resistance between the ring and ground.

Test	Activity
Insertion Loss	1. Send a 0 dBm signal using an oscillator at one of the required frequencies. 2. Use a terminated meter to measure loss at the opposite end of the cable pair.
Noise Metallic	1. Terminate one end of the circuit or cable pair with a 600 or 900 ohm in series with a 2.16 micro-farad capacitor. 2. Measure noise at the opposite end of the cable using a noise measuring set.
Power Influence	1. Connect cable pair or circuit to the 600 or the 900 ohms termination in series with a 2.16 microfarad capacitor at the central office end. 2. Use noise measuring set to make noise measurement from the field.
Structural Return Loss	1. Build out the far end to a full section 1,829 meters with a BOC (build out capacitor). 2. Terminate the far end with a PN (precision network) representing the most dominant gauge or the cable being tested. 3. Terminate the near end with a BOC and PN which match the length and impedance of the near end section. 4. Measure the structural return loss with return loss test set.
Cable Shield or Shield/Armor Continuity	Cable shields or shield/armors are electrically continuous. Shield or armor shall be bonded to ground when this test is conducted.
Conductor Continuity	All pairs are free from grounds, shorts, crosses, and opens.
DC Insulation Resistance (IR) Measurement	The expected IR levels are normally greater than 500 mega ohm/km.
Loop Measurement	Insertion loss and noise measurements shall be performed on cable pairs as DCO subscriber loops.

Commentary Note:

For documentation, a copies of used test equipment list and completed Test Record (Exhibits 1, 2, & 3) shall be attached to the MCC and PAC Forms.
(This information must be available for anytime for quality review).

8.7 Documentation

Copies of used test equipment list and completed Test Record (Exhibits 1, 2, & 3) shall be attached to the MCC and PAC Forms. (This information must be available for quality reviews by Inspection, IT Engineering Department, and the Operation and Maintenance Department).

8.8 Exchange Cable

Cable acceptance test shall be recorded according to the instructions listed in Table 8, Exchange Cable Acceptance Test Record (Exhibit 1).

Table 8 - Exchange Cable Acceptance Test Record Instructions

In Term	Specify
A	The exchange location
B	Work Order number
C	The assigned test point number
D	The assigned cable number
E	The assigned cable count
F	Temperature factor, if applicable
G	The assigned "from" location
H	The assigned "to" location
I	Shield continuity test Pass/Fair
	• Resistance unbalance (T-R) • Insulation Resistance: - Conductor (between tip and ring) - Shield(tip to ground and ring to ground)
J	• Structural Return Loss (SRL) • Insertion Loss from 500 Hz to 2,500 Hz • Conductor continuity tests, Pass/Fair • Signal-to-Noise margins: - Power Influence, Ng - Noise Metallic, Nm

8.9 Digital Line

After testing each pair between repeater housings, results shall be recorded on the Digital Test Data Acceptance Test Record (Exhibit 2) according to Table 9 instructions.

Table 9 – Digital Test Data Acceptance Test Record Instructions

In Term	Specify
A	Type of PCM Test Set used
B	Work Order number
C	Work Order number (use when different from B)
D	• Cable pair number • Loss at 772 kHz • Loop resistance

In Term	Specify
	• Resistance unbalance • Repeater slot number • Signal-to-noise • Shield continuity
E	• Cable number • Repeater housing number • Noise readings
F	• Cable section under test • Test rules of loaded pairs
G	• Transmit direction • Tester's names

Document History

30 June 2014	Revised the Next Planned Update, reaffirmed the content of the document, and reissued as major revision.
18 October 2016	Stream line and optimize communications standards based on functionality and alignment to international standards. Consolidated/merged SAES-T-628 and SAES-T-629 into one standard document.
15 January 2018	Major revision to consolidate SAES-T-634 to this standard, adding requirements pertaining to testing of copper cables, see section 8, and adding section for Definition of Terms, see Section 4.
14 May 2019	Editorial revision as part of content confirmation assessment
11 March 2021	Major revision, adoption of non-metallic materials (HDPE pipes) for underground infrastructure in alignment with SAES-T-911 and SAES-T-928. Also, adopted ANSI/ICEA S-84-608 for copper conductor technical requirements and SAES-J-902 standard for above ground installation using cable trays and conduits). Adoption of “Circular Economy” by re-use of the underground infrastructure (both copper and fiber) for temporary building.