Engineering Standard

16 June 2021

SAES-T-916
Telecommunications: Building Cable Systems, Pathways and Spaces

Document Responsibility: Communications Standards Committee

Contents

Summary of Changes

Paragraph Number		Change Type (Addition, Modification, Deletion, New)	Technical Change(s)
Previous Revision (15 February 2018)	**Current Revision** (16 June 2021)		
1	1 (Scope)	Modification	Remove the word “IT application”, considering cables (FOC and copper) for non-IT applications.
1 (bullet #1)	1 (bullet #1)	Modification	Editorial, TER (ER)
3.1	3.1	Addition	Added, two Saudi Aramco Cybersecurity Standards
3.2	3.2	Modification	BICSI TDMM aligned with 14th edition as latest revision
		Modification	TIA/EIA-569-E, updated to latest revision, (E)
		Modification	Removed TIA/EIA-568 C.1, superseded by ANSI/TIA-568.1-E
		Modification	Removed TIA/EIA-568 C.2, superseded by ANSI/TIA-568.1-E
		Modification	Remove TIA/EIA-568-B.1, superseded by ANSI/TIA-568.1-E
		Modification	Remove TIA/EIA-568-B.2, superseded by ANSI-TIA-568.2-D-2
		Modification	Remove TIA/EIA-568-B.3, superseded by ANSI/TIA-568.3-D-1
		Modification	TIA 570-D, updated to latest revision, (D)
		Addition	TIA/TSB-162B Telecommunications Cabling Guidelines for Wireless Access Points
		Deletion	IEC 60874-10, Withdraw, used ANSI/TIA-568.3-D-1 as alternate
		Deletion	IEC 60874-14, Withdraw, used ANSI/TIA-568.3-D-1 as reference
		Addition	Saudi Building Code National Committee
4	4	Addition	Defintion of Terms (new): Aerial cable, Channel, Permanent Link, telecommunications outle box, telecommunications outlet/connector
5.1	5.1	Modififcation	RCDD stamped requirement
5.1.2.2	5.1.2.2	Modification	Provide clarity
none	5.1.2.3	Addition	Provide clarity
none	5.1.2.4	Addition	Provide clarity
5.1.4	5.1.4	Modification	Provide clarity
5.1.5 (3)	5.1.5 (3)	Addition	Commentary note, usage of HDPE pipes
none	5.1.7	Addition	Add requirements address Physical Security, alignment with SACS
5.2.6	5.2.6	Addition	Added two requirements for clarification
5.2.9	5.2.9	Addition	Door opening (inward direction is permitted)

5.3.4	none	Deletion	Duplicate requirement
5.2.11 (1)	5.2.11 (1)	Modification	Clarification
5.2.11 (3)	5.2.11 (3)	Modification	Clarification
5.2.11 (5)	5.2.11 (5)	Modification	Clarification
5.2.12 (4)	5.2.12 (4)	Addition	Provide clarity for HVAC ducting requirements in alignment with SAES-M-100. Also, added a commentary note, for clarification on the used of precsion type air conditioning units and other types.
5.2.13 (1) bullet 3	5.2.13 (1) bullet 3	Addition	Prohibited on the used of carpet
5.2.14	5.2.14	Modification	Clarification
5.2.15	5.2.15	Modification/Addition	Clarification
5.2.16	5.2.16	Modification/Addition	Flood prevention clarification
5.1.17	5.1.17	Modification/Addition	Sprinkler system requirements (Table)
none	5.2.21	Modification/Addition	Alignment with TIA/EIA-E standard
5.3.6 (2)	5.3.6 (2)	Modification	20% requirements for future growth
5.3.6 (4)	5.3.6 (4)	Modification	Door opening of inward direction, it is permitted.
5.3.7	5.3.7	Modification	Clarification address to corner clearances
none	5.3.10	Addition	Cable Management requirements
5.4.3	5.4.3 (5)	Addition	Entrance facilities requirements (IT and non-IT cables)
5.4.4	5.4.4	Modification	Clarification on aerial entrance (definition)
5.4.5	5.4.5	Modification	Entrance Facility added requirements
5.4.6	none	Deletion	Deleted in the new revision
5.4.7 (bullet 3)	none	Deletion	Deleted the use of fire-rated tapes, align with NEC standard
5.4.7 (bullet 5)	none	Deletion	Deleted requirements address to obsolete installation requirement
5.4.8	5.4.7	Modification	Provide clarity
5.4.11	5.4.10	Modification	HDPE pipes, corrugated wall installation requirement for EF
5.5.1 (2)	5.5.1 (2)	Modification	Permanent link requirement
5.5.5 (2)	5.5.5 (2)	Modification	Clarification in address to conduit and sleeves
5.5.5 (5)	5.5.5 (5)	Modification	Clarification in address location
5.5.5 (8)	5.5.5 (8)	Modification	Table 5, TR room sizing requirements

5.7.1	5.7.1	Addition/Deletion	Horizontal Cabling Requirements
5.7.2 (1)	5.7.2 (1)	Modification	Horizontal Cabling/Connector Hardware requirements
5.7.2 (2)	5.7.2 (2)	Modification	Cable length “permanent link” requirements
5.7.4.3 (3)	5.7.4.3 (3)	Modification	Cable density requirements
5.7.4.9 (5)	5.7.4.9 (5)	Modification	Cable tray modification, side opening requirements clashes with HVAC ducting.
5.7.4.13 (4)	5.7.4.13 (4)	Modification	Mounting Wall Outlets Boxes installation requirements (clearances)
5.8 (2)	5.8 (2)	Modification	Deleted the Chief fire prevention Engineer requirements, and deleted commentary note.
5.9	5.9	Addition	Added commentary note
5.9.4	5.9.4	Modification	Reference NEC
none	5.12	Addition	Procedure for labelling or Assigning Identifiers to Components of the ISP Infrastructure.

1 Scope

This standard covers mandatory minimum requirements governing for the design and installation of cable system, pathway and spaces with the associate equipment used for voice and data network for Saudi Aramco owned buildings and/or facilities, as follows:

1) Telecommunications spaces, including equipment rooms [TER's (ER)], telecommunications rooms (TR's), entrance facilities (EF's), and telecommunications closet.

2) Building and campus backbone distribution systems and cabling.

3) Cabling and pathway components of the horizontal distribution system.

4) Fire stop systems.

5) Residential telecommunications cabling

6) Passive Optical Networks (PON's), refer to BICSI standards.

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 Requirement

Saudi Aramco Engineering Standards

SAES-A-112	Meteorological and Seismic Design Data
SAES-A-202	Saudi Aramco Engineering Drawing Preparation
SAES-B-014	Safety Requirements for Plant and Operations Support Buildings
SAES-B-068	Electrical Area Classifications

SAES-K-003	HVAC Systems for Communications Facilities and Data Centers
SAES-M-100	Saudi Aramco Building Code
SAES-P-103	UPS and DC Systems
SAES-T-018	Telecommunications - Symbols, Abbreviations and Definitions
SAES-T-151	Communications DC Power System
SAES-T-624	Telecommunications: Fiber Optic Cables for Outside Plant (OSP) and Inter/Intra Building Applications
SAES-T-629	Telecommunications outside Plant – Copper Cable
SAES-T-795	Grounding, Bonding, and Electrical Protection for Telecommunications Facilities
SAES-T-911	Telecommunications Conduit System Design
SAES-T-928	Telecommunications - OSP Buried Cable

Saudi Aramco Materials System Specification

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

Saudi Aramco Cybersecurity Standards

SACS-012	Physical Security Standard
SACS-033	Residential Building Connectivity Standard

3.2 Industry Codes and Standards

Building Industry Consulting Services International

TDMM	Building Industry Consulting Services International, TDMM (Telecommunications Distribution Methods Manual) -14th edition
OSPDRM	Outside Plant (OSP) Design reference Manual
	Information Transport Systems Installation Manual - 6th edition

American National Standards Institute / Electronic Industries Association

ANSI/TIA-568.1-E	Commercial Building Telecommunications Infrastructure Standard
ANSI/TIA-568-2-D-2	Balanced Twisted-Pair Cabling Telecommunications Cabling and Components Standard
ANSI/TIA-568.3-D-1	Optical Fiber Cabling Components Standards
ANSI/SCTE 15	Specification for Trunk, Feeder and Distribution Coaxial Cable
ANSI/TIA-5017	Telecommunications Physical Network Security Standard for access security control
TIA 570-D	Residential Telecommunications Infrastructure Standard
TIA/EIA-569-E	Commercial Building Standard for Telecommunications Pathways and Space
TIA/EIA TSB 67	Transmission Performance for Field Testing of Unshielded Twisted Pair Cabling Systems
TIA/TSB-162B	Telecommunications Cabling Guidelines for Wireless Access Points

International Electrotechnical Commission

IEC 60603-7	Connectors for Frequencies below 3 MHz for Use with Printed Boards

Saudi Building Code National Committee

SBC	Saudi Building Code – General

International Organization for Standardization

ISO/IEC 11801-1	Information Technology – Generic Cabling for Customer Premises

National Fire Protection Association

NFPA 70	National Electrical Code (NEC)
NFPA 72	National Fire Alarm and Signaling Code

Underwriters Laboratories, Inc.

UL 1479	Fire Tests of Through- Penetration Firestops

4 Terminology

4.1 Definitions

Aerial Cable: A cable that is suspended in air, such as pole-to-pole, building-to-National Fire Alarm and Signaling Code building or pole-to building (building exteriors in particular).

Cable pathways: Shafts, conduits, raceways, tray, floor penetrations (e.g., sleeves or slots), maintenance holes, hand holes, conduit banks (and other outside plant pathways) that provide routing space for cables.

Cabinet/Enclosure: An enclosure that houses communications equipment and ancillary systems only, designed such that equipment contained within can be accessed without the need for personnel to enter the cabinet.

Channel: The end-to-end transmission path connecting interfaces of any two pieces of application-specific equipment. Equipment cords and work area cords are included in the channel, refer as the horizontal cabling physical connectivity.

Entrance Facility (EF): The entrance facilities serve as the entrance point for the outside plant cable from a variety of sources such as the telephone (copper and fiber), network cables and other access providers. It also houses network protection devices, and may act as the demarcation point for the regulated access provider.

Inside Plant (ISP): Infrastructure (telecommunications) systems inside a building (balanced twisted-pair cabling, optical fiber cabling, coaxial cabling, racks/cabinets, cabling pathways, and information outlets) or referrer as an inside wire (IW).

Multimode optical fiber: An optical waveguide that allows many bound modes to propagate. Typically used over short distances within buildings or on a campus, refer to BICSI TDMM for classes of multimode fiber.

Outside Plant (OSP): A telecommunications infrastructure that is designed and installed externally to buildings and typically routed into an entrance facility (EF). All cables and wires in a telecommunications network that are located outside of buildings whether aerial, buried, or underground. Includes associated terminals, closures, pedestals, and supporting structures such as poles.

Permanent Link: The permanently installed portion of horizontal cabling, from patch panel) of the TER(ER) or TR to the telecommunications outlet/connector, refer as the horizontal cabling physical connectivity.

Rack: A standard equipment rack used for supporting communications equipment to be installed in an existing Building or Shelter.

Shelter: A permanent structure built on a foundation that contains or host communications equipment and its related ancillary support systems.

Telecommunications spaces: Are rooms and areas where telecommunications cabling systems are terminated, cross connected, and interconnected to installed telecommunications equipment. Bonding and grounding (earthing), firestopping, and labeling of telecommunications infrastructure also occur in telecommunications spaces - Telecommunications Equipment room [TER(ER)], Telecommunication Room (TR), Telecommunications closet), Telecommunications Entrance facility (TEF).

Telecommunication Equipment room [TER(ER)]: An environmentally controlled centralized space for telecommunications equipment that usually houses a main equipment or intermediate cross-connect.

Telecommunications Room (TR): A telecommunications space that differs from Telecom equipment rooms [TERs (ER)] and entrance facilities (EFs) in that this space is

generally considered a floor serving space that provides a connection point between backbone and horizontal cabling.

Telecommunications outlet box: A housing used to hold telecommunications outlet/connectors.

Telecommunications outlet/connector: The fixed connector in an equipment outlet.

Transmission media: The actual medium, which may be as follows: Optical fiber, Balanced twisted-pair, Coaxial, and Wireless.

Single mode optical Fiber: An optical fiber with a relatively small core diameter of 8 to 9 fiber (SMF) micrometers and a cladding diameter of 125 micrometers; light wave propagation is restricted to a single path, or mode, in single mode optical fiber.

5. Design

The BICSI (Building Industry Consulting Services International) TDMM (Telecommunications Distribution Methods Manual) is hereby recognized as the referenced detailed information. Design drawings shall use conventional symbols as specified in SAES-T-018 Telecommunications - Symbols, Abbreviations and Definitions and BICSI.

5.1 General Information

5.1.1 Communications Distribution Designer

5.1.1.1 All building telecommunications cable system design by non-Saudi Aramco design offices (such as GES, Contractor, LSTK) must be done under the design authority of a valid BICSI Registered Communications Distribution Design (BICSI RCDD). This is to ensure that a minimum level of competency has been provided in the telecommunications office/non-office building (ISP) infrastructure, these includes but not limited to, cable system design, cable entrance, pathways, racks/cabinets, patch panels, and etc.

5.1.1.2 All related design drawings shall be reviewed and stamped by a valid certified RCDD during the detailed design phase before the package can be issued for construction (IFC).

5.1.2.3 This includes all design work done internally by Saudi Aramco organizations such as ITED, Office Services, Community Maintenance and is applicable for new work, maintenance work, and/or renovations.

5.1.2.4 For design work done outside the company (GES Contractors, LSTK projects, etc.), all design work must be done by a contractor with a current/valid BICSI RCDD. The reviewing Saudi Aramco organization (SAPMT, ITED, etc.) also is recommended to have a /valid BICSI RCDD on staff as part of their review/acceptance process.

5.1.2.5 No telecommunications office building infrastructure and/or cable system design shall be “issued for construction (IFC)" without the related design work being done and stamped by a BICSI RCDD.

5.1.2 Designer Design/Construction Drawings

Construction drawings shall contain the information necessary for completing the work as designed:

5.1.2.1 Data Required

The following information must be provided on construction drawing.

a) Overall Plan of the system layout.

b) Pathways and spaces type, size & location.

c) Media type, size and number.

d) Cable schematic layout/detail.

e) Type and layout of building entrance protected terminal.

f) Equipment and accessories type and layout.

g) Telecommunication grounding and bonding system layout.

h) General Notes/Legend/Abbreviation.

i) Sizing of TER/TR and cable tray and conduit fill calcuation.

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

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

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

5.1.3 Designing Telecommunications Distribution

5.1.3.1 The building/campus cable network designer shall identify and include in the design present and future needs of 20 % for voice, data, and video communications, and provide a design that provides the capability to handle all future communication requirements without the need to completely rebuild the cable network or distribution system.

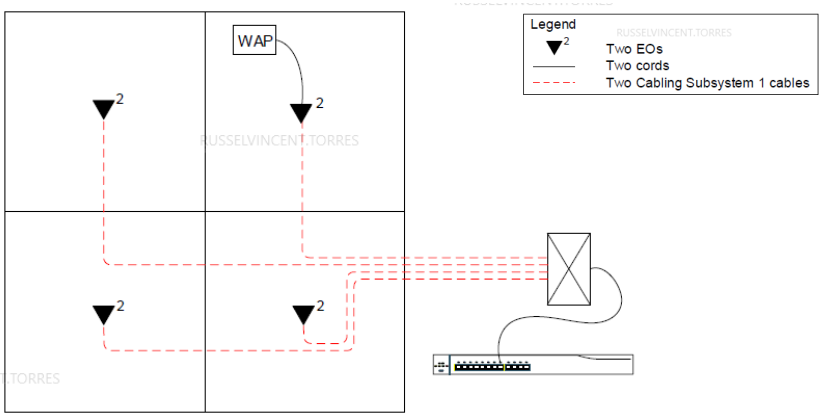
5.1.3.2 Topology, design, installation, and testing of telecommunications cabling infrastructure for supporting wireless local area networks (WLANs) shall comply with TIA/TSB-162B.

Link Aggregation for equipment Outlet Location (Telecommunication outlet/connector)

- A minimum of two EO (equipment outlet) shall be provided for WLANs.
- The WLANs cabling design shall be as per Grid-based (TIA/TSB-162B): It is recommended that the grid squares cells be used when designing coverage areas, see “Typical example of Link Aggregation”

Note:

The purpose of this grid-based is to serve as a design guide for the grid-based sizing of wireless access cells within buildings.



Typical example of Link Aggregation

5.1.4 Choosing the Transmission Medium for Horizontal Cabling

Category 6/6a UTP cabling or higher and components providing a minimum of two cables per telecommunication outlet/connector shall be used for all new installations.

Note:

Selection of transmission medium for horizontal cabling system shall be based on the current trend in the market and technology availability.

5.1.5 Support Structure

All support structures shall be in accordance with BICSI TDMM latest edition. The preferred support structures and/or cable pathways shall be as follows:

1) Cable Tray Systems - used as distribution systems for cabling within a building.
2) Conduits - these are a common method for routing cable through building walls and floors, preferred conduit size and type is one (1)

inches EMT conduit. Alternative method, one (1) inch PVC conduits for embedded in floors for serving voice and data outlets.

3) Slots and sleeves (ducts) - these are the most common methods for routing cable through building walls and floors. A minimum of 110 mm (4 inches) sleeves (ducts) with at least one spare sleeve shall be provided.

Note:

The used of 110 mm HDPE corrugated pipes, with built-in subduct shall be reviewed by the stakeholders and with the SAES-T-916 standard Chairman.

5.1.6 Structural Design Requirements

Structural reinforcement and extra environmental protection shall be provided for the equipment room design when Communication facilities are subject to being exposed to geographical locations and conditions highlighted in *SAES-A-112, Meteorological and Seismic Design Data.*

5.1.7 Physical Security

Physical security of Saudi Aramco's Computer and Communications Facilities and Resources shall comply with SACS-012, Physical Security Standard.

5.2 Telecommunications Spaces

This section specifies the minimum requirements in the design and construction of telecommunications spaces. |Also, provides guidelines for the design and construction of telecommunications spaces, including telecommunication equipment rooms [TERs (ER)], telecommunications rooms (TRs), entrance facilities (EFs), and telecommunications enclosures (TEs).

The following sections which is stated in the BICSI TDMM – latest edition shall hereby to comply, with additional requirements, exceptions and allowances as specified in section 5.2.1 to section 5.2.15.

5.2.1 Clearances (same as BICSI)

5.2.2 Dust and Static Electricity (same as BICSI)

5.2.3 Lighting (same as BICSI)

5.2.4 Sensitive Equipment and Electromagnetic Interference (EMI) (same as BICSI)

5.2.5 Cable Separation from EMI (same as BICSI)

5.2.6 Location

- Telecommunications spaces e.g. TER (ER)/TR/EF (same as BICSI)

Additional Requirements:

1) Telecommunications spaces shall be located in areas that are dedicated to telecommunications use. Equipment that is not related to the support of telecommunications spaces (e.g., piping, ducting work, distribution of building power) shall not be located in or pass through a telecommunications space.

2) Telecommunications spaces in multi-floor buildings shall be aligned vertically (stacked).

5.2.7 Acoustic Noise Levels (same as BICSI)

5.2.8 Unacceptable Materials (same as BICSI)

5.2.9 Doors (same as BICSI)

Additional requirement:

- The access door to telecommunications spaces shall be designed / constructed in such a manner that the access door open outward is preferred. In addition, ensure that the access door shall not block the hallways or corridors. In a situation that requires door opening of inward direction, it is permitted.

  Exception:

  An access door that opens to the outside of a building/structure may be permitted provided that an air-lock entryway is provided, and the Telecommunications Room access door and access security is maintained.

5.2.10 Ceiling (same as BICSI)

Additional requirement:

False or suspended ceilings shall not be permitted in Telecommunications spaces (e.g. TER (ER)/TR/EF).

5.2.11 Electric power (same as BICSI)

Additional requirements:

1) Each equipment rack shall be provided with a minimum of two (2) non-switched dedicated ac receptacles for equipment power. Each individual circuit shall be rated with a minimum 16 A at 220-240 V.

2) The outlet(s) shall be mounted on the equipment rack that is serving or at ceiling level mounted directly above the equipment rack being served. Future power requirements shall be considered when designing equipment rooms.

3) Since telecommunications equipment can be very sensitive to power abnormality, dedicated electrical power feeders, dedicated feeder/branch circuits serving individual outlet, and power conditioning shall be provided. In addition, allocate space for power conditioning, backup, or standby systems as required for the equipment

4) Provide emergency lighting

   a) Additional outlets (power strip) may be required based on the equipment plan for the room. Provide backup, standby, or emergency power sources that has automatic switch over capability, when available in the building.

   b) All outlets shall be on non-switched circuits (circuits that are not controlled by a wall/light switch or other device that may inadvertently cut power to the telecommunications systems).

   c) Power panels for dedicated electrical service shall be provided in TER/TR. Lighting fixtures shall not be powered from the same electrical distribution panel as the telecommunications equipment in the room.

5) Separate circuit duplex or quad receptacles 250 V/13A outlet for tools or field instruments, and placed at 1.8 m (6 ft) intervals around the perimeter walls at a height of 150 mm above the floor.

6) Wall-Mounted Outlets Boxes

   The wall-mounted electrical outlet boxes shall comply with SAES-M-100 for penetration requirements and SAES-M-201 for membrane penetration requirements.

5.2.12 Environmental Control - Telecommunication spaces (e.g. TER (ER)/TR) (same as BICSI)

Additional requirements:

1) HVAC system shall be designed to allow for a 20% minimum increase in equipment. The vendor's / manufacturer's specified environmental requirements for each electronic equipment item installed must be reflected on the design drawing.

2) Telecommunication spaces shall have a continuous HVAC operation (24 hours per day, 365 days per year) with an independent HVAC system controls installed inside telecommunication spaces for temperature and humidity, this is to control the room environment. In a situation where the HVAC system cannot ensure continuous operation (24 hours per day, 365 days per year), then a stand-alone HVAC unit with independent controls shall be provided for the telecommunications spaces.

3) Temperature range of 18°C to 24°C, Humidity range of 30 to 55 % , Heat dissipation hour of 750 to 5,000 BTUs per cabinet, or maintain environment required by the specific equipment to be installed.

4) HVAC Systems design consideration for Communications Facilities and Data Centers, refer to SAES-K-003 standard.

5) For HVAC duct penetration and air transfer openings shall be protected with approved fire and smoke dampers, refer to SAES-M-100. In addition, smoke detection in the duct or in the area shall be provided as necessary to actuate the damper.

6) Additional requirements shall be complied as per section 5.2.16 address to “Flood Prevention”, particular the use of precision type air conditioning units.

Note:

Other types of air conditioning units or the precision type air conditioning unit shall be reviewed by the stakeholder/s and SAES-T-916 standard chairman. This involves complying the flood prevention requirements as per section 5.2.16.

5.2.13 Floor Loading (same as BICSI)

Additonal Requirements:

1) All designs for floor loading shall be done for the maximum possible loading of the telecommunications equipment room floors in accordance to SAES-M-100, “Saudi Aramco Building Code.”

The following types of floor finishes shall only be used:

- High-pressure laminate tile
- Vinyl or other durable tile
- Carpeting is prohibited in Telecommunications spaces electronics equipment rooms [e.g. TER (ER) & TR].

2) Standard-height access/raised floor: 50 mm (6 in) or higher, refer to BICSI TDMM.

5.2.14 Security (same as BICSI)

It is mandatory of protecting the physical assets located telecommunications spaces.

Additional Requirement:

Telecommunication spaces (e.g. TER (ER)/TR/EF) shall be fitted with a combination door lock with a keypad and key, or a Sophisticated Electronic Security Systems with identification badges, and access logs.

Note:

For critical Main TER/ER, an electronic keycards/access badges shall be used to secure critical areas. This include TR’s that houses a critical circuit or communication equipment that supports critical systems such as, but not limited to, Emergency Control Centers (ECC), Security Access Control System (SACS), Video Assessment and Surveillance System (VASS), Intrusion Detection and Assessment System (IDAS), Long-Range Detection & Assessment System (LRDAS), and Automatic Number Plate Recognition System (ANPR), reference with SACS-012 Physical Security Standard or ANSI/TIA-5017: Telecommunications Physical Network Security Standard.

In case there is a conflict between the two standards (SACS vs. ANSI/TIA-5017), SACS standard shall prevail.

5.2.15 Walls, Wall Lining and Windows (same as BICSI)

Additional Requirements:

Telecommunication spaces (e.g. TER (ER)/TR/EF) walls shall:

1) Be fire-rated as required by SAES-M-100 standard, and extend from the finished floor to the structured roof or permanent ceiling/roof level.
2) Covering wall lining with two coats of fire-retardant white color paint.
3) Be fire-resistant to a minimum of 2-hour fire rated, see section 5.2.17 Fire Protection.
4) Install the plywood backboard above the underground entrance conduit. A minimum of two walls shall be covered with 19 mm thickness, and it shall be 1.2 m x 2.4 m sheets, mounted vertically, with the bottom of the plywood mounted 150 mm above the finished floor. The plywood shall be A/C grade and finished with two coats, white color of fire-retardant paint both sides.
5) Windows: Telecommunication spaces shall not have windows, refer to SACS-012, Physical Security Standard.

5.2.16 Flood Prevention

- Telecommunications spaces (e.g. TER (ER)/TR/EF) shall not be located above any threat of flooding, such as the followings;
  1) Locations that are below, above, opposite and adjacent to areas of potential water hazard (e.g., restrooms, kitchens) is not permitted.
  2) Liquid carrying pipes (e.g., water, waste, steam, HVAC ducting) is not permitted to be routed through, above, or on all wall sides of the telecommunications space.

5.2.17 Fire Protection

1) Provide fire protection for each Telecommunications spaces [TER (ER)/TR in accordance to SAES-B-014 (Safety Requirements for Plant and Operations Support Buildings) and SAES-M-100 (Saudi Aramco Building Code) .
   - It shall have a fire detection and alarm system.
   - It shall have a portable fire extinguishers with appropriate ratings and mounted as close to the entrance.
   - It shall have a smoke detection provided that meets NFPA 72 requirements.

2) Fire sprinkler systems requirement inside the telecommunications spaces shall comply with the table below.

Sprinkler System Requirements for Telecommunications Spaces

Description	If the Building is protected with a sprinkler system	If the Building is not protected with a sprinkler system
TR	• Protect the room with quick-response side wall dry barrel sprinkler, with sprinkler piping outside the room. • Separate the room with 2-hour fire-rated barrier in accordance with SBC. In addition, the construction of room shall meet the SAES-B-014 (if applicable) and SAES-M-100.	Separate the room with 2-hour fire- rated barrier in accordance with SBC . In addition, the construction of room shall meet the SAES-B-014 (if applicable) and SAES-M-100.
TER (ER) (non-critical)	• Protect the room with quick-response side wall dry barrel sprinklers, with sprinkler piping outside the room. • Separate the room with 2-hour fire-rated barrier in accordance with SBC. In addition, the construction of room shall meet the SAES-B-014 (if applicable) and SAES-M-100.	Separate the room with 2-hour fire- rated barrier in accordance with SBC. In addition, the construction of room shall meet the SAES-B-014 (if applicable) and SAES-M-100.
Main TER (ER) (critical)	• Protect the room with a Gaseous Fire Suppression or Clean Agent fire suppression systems, refer SAES-B-014 for critical communication facilities requirements. • Pre-action with Double Interlock . • Separate the room with 2-hours fire-rated barrier in accordance with SBC. In addition, the construction of room shall meet the SAES-B-014 and SAES-M-100.	• Protect the room with a Gaseous Fire Suppression or Clean Agent fire suppression systems, refer SAES-B-014 for critical communication facilities requirements. • Separate the room with 2-hours fire-rated barrier in accordance with SBC. In addition, the construction of room shall meet the SAES-B-014 and SAES-M-100.

Note:

1) ***Main TER/ER Critical**: Facilities in support of telephone, radio, or other communications links that serve vital communication functions for Saudi Aramco, the loss of which will have serious and immediate impact on oil/gas operations or the ability to operate safely. This includes communication facilities in major locations (central office facilities) and any satellite facilities where there is no alternate routing or back-up equipment (reference SAES-B-014).*

2) ***TER (ER) non-critical:** (Telecommunication Equipment Room/Equipment Room): is an environmentally controlled centralized space for telecommunications equipment, electronics equipment, or IT equipment. Also, contain terminations, interconnections, and cross-connections for telecommunications distribution cabling. In addition, this room serves an entire building to provide connectivity. It may also function as a TR serving work areas located on its floor.*

3) ***TR:** (Telecommunication Room) : a space for housing telecommunications equipment, it is considered to be floor-serving area that provides terminations, and cross-connect cabling. Also, is a point where the backbone cabling interfaces to the horizontal cabling. According to industry standards, each floor contains at least one telecommunications room as floor serving area.*

4) ***Gaseous Fire Suppression or Clean Agent fire suppression systems**: Does not replace the sprinkler system.*

3) All terminal mounting surfaces (plywood, etc.) shall be fire retardant rated or be painted on all sides with two coats of white non-conductive, fire retardant paint.

4) Firestops shall be provided when fire rated walls and floors are penetrated. The firestop shall be designed and constructed to meet SAES-M-100 (Saudi Aramco Building Code). All materials that are used to seal penetrations in fire rated walls and floors shall be listed for the specific application and comply with UL 1479 requirements. Refer to section 5.8 for additional information for Firestop System.

Exception:

Silicone Foam fire seal products shall not be used for permanent (in excess of five years) fire seals. However, it may be used as a temporary seal (less than a 5 year period) during a construction period or for seals that are frequently changed out.

5.2.18 Batteries / Uninterruptible Power Supply (UPS)

When batteries / UPS are required for backup systems, assure the design and installation complies with SAES-T-151, (Communications DC Power System), SAES-P-103, (Direct Current and UPS Systems) and manufacturer requirements.

5.2.19 High-Temperature Alarm Operation Requirement

Telecommunication spaces (TER(ER)/TR) shall be equipped with High-temperature sensor with alarm indication installed, and relayed to the Networks Operations Center (NOC) or equivalent. The alarm indicator shall be installed outside the telecommunications spaces [TER(ER)/TR].

5.2.20 Bonding and Grounding (Earthing)

Refer to SAES-T-795, Grounding, Bonding, and Electrical Protection for Telecommunications Facilities standard.

5.2.21 Common Requirements for Telecommunications Spaces

Refer to TIA/EIA-569-E standard for further clarification.

1) Racks and Cabinets

Racks are equipped with fixed or adjustable side mounting rails to which equipment and hardware are mounted.

Cabinets can be equipped with fixed or adjustable side mounting rails, side panels, a top, and front and rear doors, and it shall be equipped with locks.

a) Equipment placement:

Active equipment designed for front to back air flow should be placed in cabinets and racks with “cold” air intake at the front of the cabinet or rack, and “hot” air exhaust out the back. To improve cooling efficiency and minimize recirculation blank panels should be installed in all unused rack and cabinet spaces.

b) Clearances

A minimum of 1 m of front and rear clearance shall be provided for installation of equipment.

c) Cabinet Cooling

Cabinets shall be selected and configured to provide adequate cooling for the equipment they will house. Adequate cooling can be achieved using a number of methods including:

- Forced airflow utilizing fans;
- Natural airflow between hot and cold aisles through ventilation openings in the front and rear doors of the cabinets;
- Hot aisle/cold isle cabinet arrangement;
- Installation of blanking panels and baffles in all open spaces between and around equipment;
- Sealing air leaks around all cable ingress points;
- Containment of cold or hot air flow streams;
- Using properly sized and located air conditioning units;
- Minimizing supply and return air flow obstructions;

5.3 Telecommunications Equipment Rooms (Equipment Room) [TER (ER)]

An TER (ER) is an environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect.

In designing a telecommunications equipment room, the following reference standards specified shall applied, as follows:

BICSI	Telecommunications Distribution Methods Manual –TDMM 14th edition.
ANSI/TIA-568.1-E	Commercial Building Telecommunications Cabling Standard
TIA/EIA-569-E	Telecommunications Pathways and Spaces

Furthermore, additional requirements and exception as specified in *section 5.3.1* to *section 5.3.6* shall be complied.

5.3.1 The requirements stated in section 5.2: Telecommunications Spaces, shall be complied.

5.3.2 A TER (ER) is a special purpose room that shall provide space and maintain an operating environment for:

1) Communications and/or computer equipment.
2) Terminating and cross-connecting telecommunications distribution cables.
3) Working space for telecommunications personnel.

5.3.3 Rooms that are classified as Computer Rooms (or Server Rooms) are those that usually are designed to house a computer system for a proponent or user department that serves a specific business line. “Computer Rooms” should be located as close as possible to the telecommunications spaces (e.g. TER (ER)/TR) that provide network connectivity.

5.3.4 Design specification for a TER (ER)shall include:

1) User requirements.
2) Total usable floor space.
3) Horizontal and vertical pathway locations.
4) Environment/facility conditions and resources.
5) Logical equipment layout that is flexible enough for equipment to be added without structural renovations.
6) Assure that the access route to the telecommunications equipment room will allow for the delivery and installation of equipment.
7) Review by the IT proponent organization.

5.3.5 Locating Telecommunications Equipment Room [TER (ER)]

1) Major Consideration

The following factors shall be considered and reflected in the final design when choosing the location for Telecom Equipment room [TER (ER)]:

- Space requirements for equipment.
- Access to horizontal and backbone cable pathways.
- Building facilities
- Access to the building entrance facility.
- Proponent requirements e.g. ITED/ Area IT

- As close as possible to an approved ground source (refer to SAES-T-795 standard).

2) Provide Adequate Equipment Space

The floor space shall allow the telecommunications equipment room to provide sufficient space for the initial installation, future growth of minimum 20% and changes.

Note:

There are likely to be many equipment changes during the useful life of any telecommunications equipment room. Therefore, space shall be provided to support equipment changes with minimal disruption.

3) Access to Cable Pathways

Place the telecommunications equipment room at a location which:

- Minimizes the size and length of the backbone and horizontal distribution cables (if EF function is included).
- Is accessible to cable routing pathways.

4) Access to the Telecommunications Equipment Room [TER (ER)]

- The access door to Telecommunications Equipment Rooms [TER (ER)] shall be designed/constructed in such a manner that the access door open outward is preferred. In addition, ensure that the access door shall not block the hallways or corridors.
- In a situation that requires door opening of inward direction, it is permitted.

Exception:

An access door that opens to the outside of a building / structure may be permitted, provided that an airlock entryway is provided. In addition, it shall comply with telecommunications equipment room access door and security access requirements.

5) Telecommunication Equipment Room [TER (ER)] parameters

- Avoid locations that restrict or limit room expansion or enlargement.
- Actual weights of equipment cabinets (e.g., racks, bays etc.) and power systems (i.e., transformers, batteries) shall be used for designing the floor live loads minimum capacities (refer to BICSI). Do not exceed the distributed floor loading >12 kPa (250 lb./ft^2) and a maximum concentrated floor loading >404 kN (1000 lbs.).
- Vibration levels shall comply to SAES-M-100, (Saudi Aramco Building Code).
- Room size: Refer to BICSI TDMM latest edition for Size guidelines, Chapter 3, Telecommunications Spaces or refer to Table 5, Telecommunication Room (TR) Size Requirements.

5.3.6 Space Allocation and Layout

The layout of the major telecommunications equipment in an TER (ER) shall facilitate the routing of electrical power and telecommunications cabling.

1) Ceiling Space shall allow for a minimum of:

- 75 mm (3 in) of clear vertical space above conduits and cables.
- 300 mm (12 in) of clear vertical space above the tray or raceway for overhead ceiling cable tray or raceway systems.

2) Working Clearance

In corners, when an equipment racks (e.g., 48 cm (19 inch) is mounted parallel to an equipment room wall, a side clerance of 305 mm (12 inches) shall be maintained between the outer edge of the rack (s) and the equipment room wall.

5.3.7 Equipment Installation Methods

Equipment mounting and installation in the telecommunications equipment room shall be one of the following methods:

1) Floor Standing Racks, Frames, or Bays

Floor space is to be allocated in rows and for equipment racks installation provide a minimum space of 4820 mm. Provide space for change and growth. Locate the rack, frame and bay equipment so that electrical and telecommunications cable routing can be done efficiently. Secure and ground the hardware according to the manufacturer's instructions and SAES-T-795 recommendation.

2) Cabinets

Floor space is allocated in rows. This is typical for large electronic telecommunications equipment (e.g., voice and data switching systems, computer equipment). Cabinets are used to provide:

- Physical protection.
- Electromagnetic compatibility.
- Dust and contaminant protection.

Cabinets shall be secured to the building structure and grounded in accordance with the manufacturer instructions and SAES-T-795 recommendation. Raised floors are required for equipment cabinets which require air conditioning from the bottom of the cabinet.

5.3.8 Equipment Installation Methods

The following are acceptable installation methods:

- Sleeves
- Conduit

  Note:

  Bushings shall be placed on the ends of metallic conduit to protect cable sheaths from damage.

- Overhead cable tray

  This method is acceptable for routing equipment cable to the cross-connect and for routing backbone cables to the backbone pathway.

  Tray locations shall be coordinated with lighting, air handling systems, fire extinguishing systems, etc., so that trays will not obstruct or impede system operation. Tray installations and ratings shall comply with the requirements of NEC Article 392 and TIA/EIA-569-E.

  Note:

  Cable trays shall not house or support cable splice closures. Provide adequate wall space for mounting splice closures vertically or horizontally.

- Raised Floor

  Typically used when large equipment rooms house both telecommunications and computer equipment which require cabling and air conditioning from the cabinet bottom.

5.3.9 Cable Management Requirements

- Vertical management or cable management shall be placed between equipment racks for easy management and convenient run of patch cords and for extra security.
- When placing equipment rack, a vertical cable management panel shall be placed on at least one side of the rack or between the rack and the room wall. Cable management panels need to be sized to allow the placement and management of contained cables and patch cords.
- When multiple racks are used, vertical cable management panels should be placed between each rack, with additional panels at each end.
- Cabinets and enclosures should have self-contained or integrated vertical cable management.
- In addition to vertical cable management, horizontal cable management panels may be utilized to manage the patch cords between the patch panel and the equipment. The ratio of one RU patch panel to one RU horizontal cable manager plus one additional RU cable manager is recommended.

- When angled patch panels are installed, the use of vertical cable management is recommended.

5.4 Entrance Facility (EF)

The entrance facility (EF) consists of the telecommunications service entrance to the building, including the entrance through the building wall, and continuing to the entrance room or space. The entrance facility may contain the building pathways that link to the TER (ER) , and to other buildings within the site locations.

In designing entrance facility (EF), the following reference standards specified shall applied, as enumerated below:

TIA/EIA 568-B	Customer-Owned Outside PlantTelecommunications ` Infrastructure Standard.
TIA-569-E	Telecommunications Pathways and Spaces.
BICSI	Telecommunications Distribution Methods Manual –TDMM latest edition.

5.4.1 The EF shall be designed and installed in accordance with the requirements of TIA-569-E standard.

5.4.2 The requirements stated in section 5.2: Telecommunications Spaces shall all be complied.

5.4.3 Functions of Entrance Facility (EF):

1) Network Demarcation
2) The EF must be the demarcation (termination point) for cables designated for outdoor use and cables designated for indoor use.
3) Connections to outside plant (OSP)cabling
4) Served as the conenction point and transition points between the cables designated for outdoor use and cables designated for indoor use.
5) The EF for IT cables feeding through the TER/TR, shall not be combined with non-IT cables. The non-IT cables EF shall not routed on the same building entrance.

5.4.4 Type of Entrances

Saudi Aramco acceptable methods for an entrance pathway facility shall be constructed as follows:

1) Underground Entrance: use conduit to provide out-of-sight service to a building.

2) Buried Entrance: provide out-of-sight service to a building without conduit (e.g. trenched, plowed).

3) Aerial entrance: provide overhead service to a building, such as pole-to-pole, building-to-building or pole-to building (building exteriors in particular).

Note:

Aerial construction shall only be approved through a waiver, and shall comply with BICSI OSPDRM installation requirements. The use of cable trays and conduits is an above ground installation and it is not an aerial type. An aerial installation means a cable that is suspended in air.

5.4.5 Entrance Facility (EF) Requirements

1) A EF shall be fitted with a combination door lock with a keypad and key or a Sophisticated Electronic Security Systems with identification badges, and access logs.

2) Buildings having 10,000 m² (100,000 ft²) or more of usable floor space shall have a dedicated entrance facility (EF) room.

3) The EF pathway (corridor/pasageway) or space's shall meet the requirements as stated in section 5.2: Telecommunications Spaces, with an additional requirements and exceptions as specified in section 5.4.

4) An approved ground source, refer to SAES-T-795 standard.

5) Antenna cable entrances shall be isolated from other entrance and backbone cables.

6) Radio cable for DAS (micro antenna) shall be installed separately through conduits or cable tray.

Note:

A vertical mounted wall frame protector shall be provided for buildings exceeding 6,000 m² (60,000 ft²) of usable floor space. This only applies to Telecom facilities having more than a 600 pair copper cable building terminal. Free standing frames may also be considered for cable terminations.

5.4.6 Terminating Space for Entrance Facilities (EF)

1) Terminating space shall be near or at the point where the cable physically enter the building.

- A transition splice point from outside plant (OSP) non-fire rated to indoor fire rated cable shall be made to limit the exposed non-fire rated cable to 15 m or less.
- Never run more than 15 m (50 ft) of non-fire rated entrance cable within a building. This distance cannot be extended by enclosing the cable in additional conduit.

- One of the following actions shall be taken if a situation requires more than 15 meters of entrance cable between the entry point and the termination point.
  i. Relocate the cable entrance point so that it is within 15 meters (50 feet) of the termination point.
  ii. Relocate the termination point so that it is within 15 meters of the cable entrance point.
- Cable splices shall not be mounted or placed in overhead cable trays or below raised floors. It shall be accessible to cable technicians at floor level.

2) The non-fire rated cables (with metallic elements) shall end at the outside plant splice rack (i.e., cable vault, horizontal cable ladder rack, vertical cable ladder rack, etc.)

Notes:

- *800 mm (30 in) shall be the minimum distance from the finished floor level up to the bottom end plate of the splicing case, if splice case is installed vertically.*
- *If cable loop is required then it shall be made at the maintenance hole or at the cable vault or placed at dedicated pedestals.*

3) An OSP non-fire rated cables (with metallic elements) shall not be installed on overhead equipment cable ladder racks.

4) Physically protected:

Larger terminations require a separate room set aside for the use of telecommunications purposes (voice, data, broadband etc.) only.

Buildings 100 m² or smaller may have terminations placed inside metallic cabinets such as the Type 3A cabinet as long as active equipment is not involved. The 3A cabinet interior dimensions are 1,220 mm (H), 495 mm (W) & 127 mm (D).

`5.4.7 Underground Conduit Entrance

5.4.7.1 Requirements for a cable entering a telecommunications facility or buildings for copper and fiber optic cables, refer to SAES-T-911 for OSP cable.

5.4.7.3 General Requirements for Underground Entrances

Design conduits entering from below grade point to extend 100 mm (4 in.) above the finished floor.

1) Conduits shall not be located more than 5 cm (2 in) from the rear wall having the backboard and not less than 15 cm (6 in) from the side wall.

2) Design conduits to be located near the left corner to allow for expansion toward the right.

3) Sealing Entrance Conduit inside a Building:

All building entrance conduits shall be plugged or sealed in accordance to this standard, see section 5.8 Firestop System.

5.4.8 Pull Points and Pull Boxes for Conduits

5.4.8.1 The necessary requirements to this section shall be designed and installed in accordance with the requirements stated on BICSI TDMM standards, see section “Pull Points and Pull Boxes for Conduits” – Chapter 5.

5.4.8.2 Refer Table 5.8 of BICSI TDMM standards, “Typical space requirements for pull boxes having conduit enter at opposite ends of the box” or the pull box sizing requirements.

5.4.8.3 Indoor Conduit Bends Requirements

Conduit bends must be long, sweeping bends. Conduits shall have a minimum bending radius of 10-15 times the internal conduit diameter depending on type of cables to be installed.

Unshielded	10 times
Shielded	12 times
Shielded & armored	15 times

5.4.9 Buried Entrance

Direct buried entrance design and construction shall be done in accordance to SAES-T-629 (Telecommunications Outside Plant – Copper Cable), SAES-T-911 (Telecommunications Conduit System Design) and SAES-T-928 (Telecommunications - OSP Buried Cable).

5.4.10 Other Telecommunications Entrance Facility Considerations

5.4.10.1 When planning for Campus Arrangements and Core-Building Arrangements, refer to the latest BICSI TDMM latest edition for information regarding, “Campus Back Bone Systems.”

5.4.10.2 Inter Building Pathways

Buildings as described in paragraph section 5.4.10.1 above shall be inter-connected by the most direct route (straight line) to provide inter-connectivity. This shall be accomplished by installing a minimum of 110 mm (4) inch PVC conduits. This requirement is in addition to the normal building Telecommunications Entrance Facility requirements.

Both pathway ends shall terminate in telecommunications spaces TER(ER)/TR/EF of the connected buildings. All conduit design and construction shall comply with SAES-T-911.

Note:
Installation of HDPE pipes, corrugated wall, with built-in subduct for interconnection (Inter Building Pathways) shall be reviewed by the stakeholders and Communications standard Chairman.

5.5 Telecommunications Room (TR)

TR design shall consider incorporation of other building information systems in addition to traditional voice and data needs (e.g., CATV, wireless networks, alarms, security, audio, other building signaling systems).

In designing a telecommunications equipment room, the following reference standards specified shall applied, as follows:

BICSI	Telecommunications Distribution Methods Manual –TDMM latest edition.
TIA/EIA-568-B series	Commercial Building Telecommunications Cabling Standard (B, B1, B.2 & B.3).
TIA/EIA-569-E	Telecommunications Pathways and Spaces

Furthermore, additional requirements and exception as specified in section 5.5.1 to section 5.5.5 shall also be complied.

5.5.1 Telecommunications Rooms Guidelines, (same as BICSI).

In addition, lists of requirements, exceptions and allowances as specified below.

1) The requirements stated in section 5.2: Telecommunications Spaces shall be complied.
2) There shall be at least one TR per floor area and there is no maximum number of TR's that may be provided within a building.
3) An additional TR shall be placed when the distances between the IWA and the Telecommunications Room exceed the maximum permanent link length (90 meters [295 feet]) as for horizontal cabling.

5.5.2 Buildings serving area larger than 100 m² (1076 ft²) in size (usable space), it shall have a Telecommunications Room. In multi-story buildings a minimum of one Telecommunications Room shall be provided for each floor level. There is no maximum number of TR's that may be provided within a building, see section 5.5.5 (8) "Size Requirements."

5.5.3 Combined with an Entrance Facilities is permitted.

5.5.4 The TR may serve as or contain a building telecommunications entrance facility provided that the space requirements for the Entrance Facility and the Telecommunications Room are combined to provide for both space requirements in one room.

5.5.5 Design Consideration for Telecommunication Room (TR)

1) Identification Methods

The following table provides the color coding for cross-connect fields inside Telecommunications Spaces [TER(ER)/TR]:

Table 4 – Color Codes Scheme

The Color	Identifies
Orange	Demarcation point (i.e., to MOPTT/Saudi Telecom.).
Green	Network connection (Saudi Aramco Service) i.e., network and auxiliary equipment)
Purple	Common equipment, PBX, LANs, Muxes (i.e., switching and data equipment)
White	First level backbone (i.e., main cross-connect to a horizontal cross-connector or to an intermediate cross-connect. Telecommunications Room or to intermediate cross-connect).
Gray	Second level backbone (i.e., intermediate cross-connect TR).
Blue	Station Cable (i.e., Horizontal cables and wires)
Brown	Inter-building backbone (i.e., campus cable terminations). **Note:** Brown takes precedence over white or gray for inter building runs.
Yellow	Miscellaneous (i.e., auxiliary, alarms, security, etc.).
Red	Reserved for future use (also, key telephone systems).

Notes:

1. *Methods for color coding termination fields include the use of colored backboards, connections, covers, or labels.*
2. *These color assignments identify termination and cross-connection fields only. They do not apply to protection apparatus or other elements of the wiring systems for which other color schemes may be used. Refer to the illustration (0406) for color code scheme.*

2) Locating Conduits and Slots/Sleeves

Conduits and slots/sleeves systems shall be located in places where pulling and termination can be accomplished safely and without damaging cable. Conduits, slots/sleeves shall not be located more than 5 cm (2 inches) from the rear wall and not less than 15 cm (6 in) from the side wall.

Conduits and slots/sleeves shall be sealed with an approved seal or firestop material immediately after cable installation. Firestop and seals shall be sealed in accordance with the Fire stopping section, SAES-T-629, SAES-M-100 (Saudi Aramco Building Code) and SAES-B-068 (Electrical Area Classifications).

3) Quantity and Size for Conduits and Sleeves

A minimum of three 110 mm (4 inches) sleeves or conduits shall be provided for the backbone pathways.

- One (1) 110 mm (4 inches) sleeve or conduit shall be provided for every 5000 m² (50,000 ft²) of usable floor space served by the backbone system. In addition, a minimum of two (2) spares (100 mm sleeves/conduit) provided in addition to the initial requirement.
- A minimum of 2 pcs. with (7.62 cm) 3 inch. of conduits or a cable tray shall be provided when linking two Telecommunications Rooms (TR) to each other. Larger conduits are to be provided when required by the service demands. A minimum of one spare or vacant conduit shall be provided.
- Overhead pathway (trays, conduits, trunks, etc.) entries into the TR shall protrude into the room a distance of 5 cm (2 inches) maximum at a minimum height of eight (8) feet (243 cm).

4) Requirements for Quantity of Telecommunications Rooms

Corporate buildings (single or multi-level) shall have as a minimum one Telecommunications Room (TR) on each floor level. The number of required TR's shall be based on the usable office space.

Notes:

Corporate building means offices, hospitals, or dormitories.

5) Location

The following shall be observed when positioning a Telecommunications Room (TR):

- The access door to telecommunications spaces shall be designed / constructed in such a manner that the access door open outward is preferred. In addition, ensure that the access door shall not block the hallways or corridors.
- In a situation that it requires door opening inward position, then it is permitted.

  Exception:

  An access door that opens to the outside of a building / structure may be permitted, provided that an airlock entryway is provided. In addition, it shall comply with telecommunications equipment room access door and security access requirements.

- Horizontal cable runs or length of each outlet cable shall not exceed the permanent link of 90 meters (295 feet).

- Place TR's in the core area where feasible of multi-level building so that they are vertically arranged directly above and below connecting TR's.

6) Electrical Power

Telecommunications Room(s) shall be equipped with:

- A minimum of two dedicated 3-wire 230-volt AC duplex electrical outlets which are on separate circuits and 20 ampere rated service breakers. If more than two equipment racks are needed, provide a minimum of one additional dedicated AC duplex electrical outlet for each equipment rack.
- Two (2) dedicated 20 AMP, 230-volt AC duplex electrical outlets, each on separate circuits for equipment power when equipment rack(s) are installed. Outlet(s) shall be mounted on the equipment rack that it is serving or at ceiling level mounted directly above the equipment rack being served.
- Separate duplex 230-volt AC convenience outlets (for tools, test sets, etc.) which are Located at least 6-inches above the floor and placed at 1.8-meter (6 ft.) intervals around perimeter walls.
- All outlets shall be on non-switched circuit (circuits that are not controlled by a wall/light switch or other device that may inadvertently cut power to the telecommunications systems).
- Power panels for dedicated electrical service shall be provided in a TR when active equipment is planned or installed.

Note:

Lighting fixtures shall not be powered from the same electrical distribution panel as the telecommunications equipment in the room.

7) Wall and Rack Space for Terminals

Locate space for terminations of each separate cable type on one continuous wall or rack. The Designer shall plan for:

- A minimum clear space of 130-150 mm (5-6 inches) above and below the top and bottom connecting blocks for cable handling and additional rack or backboard space for routing cables and/or cross-connect jumpers. Corners result in 150-300 cm (6 to 12 inches) of lost space on each wall and make ring runs necessary. Reserve narrow side walls for: splice cases, miscellaneous items.
- Cross-connect fields, patch panels, and active equipment in the TR shall be placed to allow interconnection via jumpers/patch cords and equipment cables whose combined length does not exceed.

- 6 meters (20 ft.) per link for horizontal cross-connections and interconnections. (TR)
- 20 meters (66 ft.) per link for other cross-connections and interconnections. (IC, MC)

8) Telecommunication Room (TR) Size Requirements

The minimum service requirements shall be based on distributing telecommunications service to one individual work area (IWA) per 10 m² (100 ft²) of usable floor space. The minimum Telecommunications Room sizes are shown in the Table 5:

Table 5 - Telecommunications Rooms (TR) Size

If A Serving Area Is	Then the interior dimension of the room shall be at least
Larger than 929 m²	Multiple TR's are required
Larger than 743 m² and less than or equal to 929 m²	Minimum TR size of 3.0 m X 3.4 m
Larger than 465 m² and less than or equal to 743 m²	Minimum TR size of 3.0 m X 2.7 m
If equal to 465 m² or less	Minimum TR size of 3.0 m X 2.4 m
If smaller than 93 m²	• Wall-mounted cabinet • Self-contained cabinet. • Enclosed cabinets.
NOTE: (Reference BICSI TDMM) 1) The size of 3 m X 2.4 m is specified here to allow a center rack, cabinet, or enclosure configuration. 2) A wall-mounted with minimum size of 12 U, which have an active equipment for 1 network switch. 3) When an UPS is added, then use a floor-mounted cabinet type, minimum of 48 U. 4) A shallow closed is not permitted. 5) Key systems or data equipment relay racks require a depth of at least 920 mm. 6) All cabinets shall be listed and marked in accordance with applicable electrical codes. 7) Installation of active equipment requires environmental control and a dedicated power circuit.	

9) Layout Considerations

The design of a Telecommunications Room shall include the Table 6:

Table 6 – Telecommunications Room Layout Considerations

If	Then
A substantial portion (>40%) of the room is dedicated to backbone cable distribution	Space shall be provided for splicing and ladder racking
Special telecommunications services are provided	Allow additional space for termination hardware and (possibly) active equipment

10) Termination Space

The table below lists the minimum requirements for estimating space requirements when planning for cable terminations:

Table 7 – Space Requirements for Cable Termination's

For	Allocate
UTP cable cross-connects or patching (see note 1)	26 cm² (4 in²) for each 4-pair circuit to be patched or cross-connected (allows for two 4-pair cable termination's and or two 4-pair modular patch connections per circuit).
Optical fiber cross-connects or patching	13 cm² (2 in²) for each fiber pair to be patched or cross-connected (allows for two cable/patch connections per channel).

Notes:

1. *When cable terminations require surge protection, the recommended space allocation is two to four times larger than the space for regular cross-connections/patching.*
2. *These space allocations do not include cable runs to and from the termination fields. Up to 20% or more space may be required for proper routing of cables, jumper wires, and patch cords.*

11) Telecommunications Rooms in the Core of a Multistory Building

TR (s) shall be located in or adjacent to the core area of a multi-story building when the core area is centrally positioned in the structure.

Other floor serving TR's may be provided in locations away from the core area of a building due to excess horizontal cable lengths or zone serving configurations. TR's shall be inter-connected to TR's serving the same floor.

When the core area is not centrally positioned in a multi-story building the TR's may be positioned away from the core area so long as the TR's is centrally positioned in a serving area or zone.

5.6 Building Backbone Cabling

A backbone system (also known as a "Riser System") is the part of a premises distribution system that provides physical interconnection between Telecommunications Equipment Rooms, TER's (ER), and Telecommunications Service Entrance. This system usually consists of one or more copper and or fiber optic cable systems with associated equipment.

5.6.1 Transmission Media

1) Recognized Cabling

The transmission media, which shall be used individually or in combination in the backbone cabling. The recognized media are:

- 100-ohm twisted-pair cabling: category 3, category 5e, category 6 or category 6A (refer to ANSI/TIA/EIA-568-2-D).
- Multimode optical fiber cabling (ANSI/TIA-568.3-D)
- Single-mode optical fiber cabling (ANSI/TIA-568.3-D).

Note:

Refer to SAES-T-624 for fiber optics cables additional requirements.

2) Multi-mode fiber is the link between the TR to the TER's (ER) shall consist of a minimum of 12 cores of 50/125 MM fiber (OM3, Laser Optimized Fiber). In addition, it is also recommended to consider having 12 cores of Single Mode fiber to allow a cross-connect to the OSP fiber at the TER(ER).

5.6.2 Backbone Cable Lengths

The following distance limitation specifications are provided to ensure that the backbone can accommodate data transmission applications.

1) From Telecoms Room to Intermediate Cross-Connect (IC)

The total length of transmission cable between the TR cross-connect and the intermediate cross-connect shall not exceed 500 meters (1640 ft.) for data applications.

2) From Telecoms Room to Main Cross-Connect (MC)

The total length of transmission cable between the TR or equipment room and the main cross-connect (including to and from any intermediate cross-connects) depends upon the cable type shown below:

Table 8 – Backbone Distances

If the Transmission Cable Is	Then the Maximum Length from the Telecommunications Room to the Main Cross-Connect is
multimode optical fiber	2,000 meters (6,560 feet)
100-OHM UTP	800 meters (2,630 feet)
Single-Mode Fiber	3,000 meters (8,200 feet).

When TR to IC distance is less than the maximum, the IC to MC distance can be increased accordingly.

5.6.3 Types of Backbone Cable Pathways

The following distance limitation specifications are provided to ensure that the backbone can accommodate data transmission applications.

1) Vertically Aligned Telecommunications Rooms

With connecting sleeves or slots is most common backbone, Backbone cable sheath shall be accessible on each floor, circuits can be distributed as required. Ensure proper fire stopping is maintained at all times.

2) Sleeves

Cable sleeves shall be vertically aligned in multi-level Telecommunications Rooms. Sleeves shall be positioned adjacent to a wall on which the backbone cables can be supported. Sleeves shall not be placed in such a manner as to obstruct wall termination space or areas for mounting cable splice cases. Sleeves are not to be placed above or below wall space areas that are to be used for termination fields. Wall space shall be provided at a floor working level for splice case mounting and cable racking. Vertical ladder racks shall be placed on the wall at each opening (sleeve) to provide support for cabling and splice cases. Sleeves shall conform to NEC and local fire codes. Sleeves shall extend 2.54 centimeters (1 inch) above the floor level.

Note:

Ensure that proper fire stopping is maintained at all times. See fire stopping section for additional information

3) Sizing Floor Sleeves

The table below provides information for determining the minimum number of 10 cm (4 in.) floor sleeves that are required to serve a facility. This ratio can be increased as necessary to provide for specific needs to the area being served.

Structural changes and floor penetrations shall be accomplished in accordance to SAES-M-100, (Saudi Aramco Building Code). Major structural modifications to floors shall be reviewed by Consulting Services Department.

Note:

Design all sleeves with a minimum diameter of 10 cm (4 in.).

Table 9 – Sleeves

Total Square Meters (Feet)	Quantity of Sleeves
Up to 5,000 (50,000)	3
5,000 (50,000) to 10,000 (100,000)	4
10,000 (100,000) to 30,000 (300,000)	5 – 8
30,000 (300,000) to 50,000 (500,000)	9 – 12

All structural changes and floor penetrations must be approved by a registered structural engineer.

5.6.4 Miscellaneous Support Facilities (same with BICSI).

1) Supporting Strand
2) Open Cable Shafts.
3) Other Methods for Securing Vertical Backbone Cable (refer to BICSI).

5.6.5 Cable Markings and Material

1) Cable Markings

All cabling shall be identified and marked with one of the following. The following table summarizes Table 800-50 of the National Electrical Code.

Table 10 – Copper Conductor Cable Markings

Cable Marking	Type	Reference Sections
MPP	Multipurpose Plenum Cable	800-51, 800-53
CMP	Communication Plenum Cable	800-51, 800-53
MPR	Multipurpose Riser Cable	800-51, 800-53
CMR	Communication Riser Cable	800-51, 800-53
MPG	Multipurpose/General Purpose Cable	800-51, 800-53
CMG	Communications General Purpose Cable	800-51, 800-53
MP	Multipurpose Cable	800-51, 800-53
CM	Communications General Purpose Cable	800-51, 800-53
CMX	Communication Cable, Use Limited	800-51, 800-53
CMUC	Under carpet Comm. Wire & Cable	800-51, 800-53

2) Cable Substitutions

The following table summarizes Table 800-53 of the National Electrical Code.

Table 11 – Copper Conductor Cable Substitution

Cable Type	Permitted Substitution
MPP	None
CMP	MPP
MPR	MPP
CMR	MPP, CMP, MPR
MPG/MP	MPP, MPR
CMG/CM	MPP, CMP, MPR, CMR, MPG, MP

Cable Type	Permitted Substitution
CMX	MPP, CMP, MPR, CMR, MPG, MP, CMG, CM

3) Fiber Optic Cable Markings

Table 12 – Fiber Optic Cable Markings

Cable Marking	Type	Reference Sections
OFNP	Nonconductive O.F. Plenum Cable	770-51,770-53
OFCP	Conductive O.F. Plenum Cable	770-51,770-53
OFNR	Conductive O.F. Riser Cable	770-51,770-53
OFCR	Conductive O.F. Riser Cable	770-51,770-53
OFNG	Nonconductive O.F. General Purpose Cable	770-51,770-53
OFCG	Conductive O.F. General Purpose Cable	770-51,770-53
OFN	Nonconductive O.F. General Purpose Cable	770-51,770-53
OFC	Conductive O.F. General Purpose Cable	770-51,770-53

4) Fiber Optic Cable Substitutions

The following table summarizes Table 770-53 of the National Electrical Code.

Table 13 – Fiber Optic Cable Substitution

Cable Type	Permitted Substitution
OFNP	NONE
OFCP	OFNP
OFNR	OFNP
OFCR	OFNP, OFCP, OFNR
OFNG, OFN	OFNP, OFNR
OFCG, OFC	OFNP, OFCP, OFNR, OFCR, OFNG, OFN

5) Backbone Cables Splice Locations

Backbone cables shall not be spliced in pathways (raceways, conduits, trays, trunking) in ceilings and under raised floors. Cable splice points shall be placed in an area designated for cable splice closures in telecommunications room (entrance facility, equipment room or TR). The splice point shall be accessible to cable technicians at floor level and supported by cable racks.

6) Backbone Cabling and Connectors Performance Testing and Inspection

Performance testing and inspection for Backbone Cabling (UTP, STP and Fiber Optic) and connectors shall be accomplished in accordance to SAES-T-624 for Fiber optic cable and SAES-T-629 for copper cables and/or TIA/EIA-568A.

All test results shall be documented by recording the test data on as-built drawings and documentation package.

5.7 Horizontal Distribution systems

A horizontal distribution system consists of the horizontal cabling, the horizontal pathways supporting the horizontal cabling, and the telecommunications spaces that support the horizontal pathways.

5.7.1 Horizontal Cabling System

A horizontal distribution system consists of the horizontal cabling, the horizontal pathways supporting the horizontal cabling, and the telecommunications spaces that support the horizontal pathways.

A horizontal cabling system includes but not limited to the following elements, refer to BICSI TDMM for clarification.

• Work area equipment cord

• Work area connecting hardware, e.g. Telecommunications outlets/connectors, MUTOAs

• Horizontal distribution cables

• Connecting hardware e.g., wiring blocks, patch panels

• Jumpers and patch cords used to configure horizontal cabling Connections.

• Equipment cords, typically located in the ER TR, or TE

5.7.2 Horizontal Cabling and Connection Hardware

1) Design Consideration

- Horizontal distribution pathways and spaces shall be designed to provide a minimum of one square inch per IWA (10 m²).
- Horizontal distribution pathways and spaces shall be designed with a minimum of 20% spare capacity for the system expansion, maintenance, and relocation activities.

- The principles for horizontal distribution systems are also used for non-commercial building applications (e.g., health care and industrial/plant facilities).
- Allows for the accommodation of change over the facility's life cycle with the goal of reducing long-term maintenance and operational costs. Includes appropriate pathway and cabling components to accommodate ease of access.

2) Cable Lengths

- The maximum horizontal distance or permanent link length of each outlet cable shall be 90 m (295 ft.) for all horizontal distribution cables.
- Patch Cords that connect horizontal cabling with equipment or backbone cabling, shall not exceed 5 m (16 ft.) in length.
- For each horizontal channel, the total length allowed for cords in the work area plus patch cords or jumpers plus equipment cables or cords in the telecommunications rooms shall not exceed 10 m (33 ft.).

  Note:

  All equipment cables shall meet the same performance requirements as the patch cords, connectors, and jacks/plugs or higher.

- A maximum of four connection points (four connectors) is permitted in the channel, as follows, (1) telecommunications outlet/connectors or MUTOAs, (2) connector of the first unit of connecting hardware, (3) CP connector (optional), (4) connector of the second unit of connecting hardware, refer to BICSI TDMM for more details.

3) Topology

Horizontal cabling shall be installed in a star topology. Each work area outlet shall be cabled directly to a TR. Horizontal cabling cross-connect shall not contain transition points between different forms of the same cable type (i.e., from round cable to flat under carpet cable).

Note:

Bridged taps (multiple appearances of the same cable pair at several distribution points) shall not be permitted in horizontal distribution wiring.

4) Transition Points

Horizontal cabling shall not contain transition points between different forms of the same cable type (i.e., from round cable to flat under carpet cable).

Horizontal cabling shall not contain a splice point between termination points (cross-connects and outlets). Horizontal cable

sections that are too short to reach outlets or cross-connects shall not be spliced to add length to them.

5) Cable Slack

- Only the minimum amount of slack of required for the outlet termination shall be left in the telecommunications outlet box (or equivalent space) so that the minimum cable bend radius requirements shall not be exceeded.
- In the TR, provide a minimum of 3 m cable slack if the termination hardware is wall mounted (including wall or floor mounted equipment cabinets) and 1 m of cable slack if the termination point is in a free-standing equipment rack.

Notes:

i. Include the slack in all length calculations to ensure that the horizontal cable (permanent link) does not exceed the permanent link requirement of 90 m (295 ft.).

ii. All testing must take place after the outlet and slack cable have been placed in the telecommunications outlet box (or equivalent space) to ensure that overall link performance was not adversely affected by the storage of the slack cable.

5.7.3 Horizontal Cables

5.7.3.1 Cable Types

The two types of cables recognized for use in horizontal distribution cabling are:

- Copper cables: Four-pair 100-ohm unshielded category 6 twisted-pair (UTP) cable or higher.
- Fiber Optic cables: Multi-mode and/or Single mode.

5.7.3.2 Horizontal Media Selection

The horizontal cables provided to each individual work area shall consist of telecommunications outlet/connectors connected to:

- 4-pair 100-ohm balanced category 6 or higher, and
- Any one of the following (depending on the anticipated needs of work area occupants):
  - Four-pair 100-ohm unshielded category 6 twisted-pair (UTP) cable or higher.
  - 2 or more strands of Multimode optical fiber cable.
  - 2 or more strands of Single Mode optical fiber cable.

5.7.3.3 Optical Fiber

When projected needs include optical fiber, fiber may be installed in addition to the two required outlets. Use a dedicated cable to distribute optical fiber (rather than using a hybrid cable).

5.7.3.4 Horizontal Connecting Hardware

Connecting hardware used for horizontal cable connections shall meet the requirements for reliability, safety, and transmission performance specified in ANSI/TIA and NFPA-70.

1) Equipment Connections

Do not connect horizontal cables directly to premises equipment. Instead, use suitable connecting hardware and cable to make the connection. Locate patch panels and cross-connect blocks so that the combined length of cables and line cords used to connect equipment in the work area and TR, plus the patch cable, does not exceed 10 m (33ft.).

2) Work Area Outlets

Locate work area outlets so that the cable required to reach work area equipment will be no more than 5 m (16 ft.) long.

Notes:

a) Work area outlet box shall be located near an electrical outlet (within 1 meter) and installed at the same height if appropriate to provide electrical power for telephone sets.

b) An electrical outlet shall be provided for each work area data outlet. Coordinate furniture layouts with the proponent representative.

3) Outlet Adapters

Electrical components (e.g., impedance-matching devices) which some applications require at the telecommunications outlet shall not be installed as a part of the horizontal cabling. When these components are used, they must be located outside the faceplate via a standard plug connection.

4) 100-Ohm UTP Cable Outlets

Each four-pair 100-ohm UTP shall be terminated in an eight-position modular jack at the work area. The outlet shall meet the standard interface and reliability requirements of the specification IEC 60603-7. All Connectors that provide electrical connections between 100-ohm UTP cables shall meet the requirements of ANSI/TIA/EIA-568-B.2 or ISO/IEC 11801 Ed.2:2002.

The pin/pair assignments for these eight-position modular jacks at the work area shall meet T568A or, optionally, per

T568B if necessary to accommodate certain 8 pin cabling system. Refer to the latest issue of the BICSI TDMM. T568B termination only to be used in existing locations undergoing minor renovations.

5) Multimode and Single Optical Fiber Outlets

Horizontal multimode optical fiber cable shall be terminated by a duplex SC-style or ST-style outlet connector (as specified in ANSI/TIA-568.3-D-1).

6) Information Outlet for Indoor Wireless Access Point(s)

For Saudi Aramco buildings having a wireless connectivity, the access point for voice/data outlets shall not be installed more than 3.75 meters above finished floor level, refer to TIA/TSB-162 standard.

5.7.3.5 Cross-Connect Wires and Patch Cords

Length Requirements:

Horizontal cross-connect wires and patch cords shall not exceed a length of 5 m (16 ft.).

Systems designers shall plan for a combined maximum cable length of 10 m (33 ft.) for patch cords and for equipment connections in the work area and TR. This length is in addition to the permanent link of 90 m (295 ft.) of cable allowed between the TR and work area outlet.

5.7.3.6 Cabling Practices

Connector Termination Practices: The amount of untwisting for UTP cabling shall not exceed 13 mm [0.5 inches] for Category 6 cables.

5.7.4 Horizontal Pathways

The requirements in this section are based on commercially accepted best practices. Horizontal pathways consist of structures that conceal, protect, support, and provide access to horizontal cabling between the telecommunications outlets/connectors used to connect work area equipment at the work area in the serving ER, TR, or closet.

5.7.4.1 Avoiding Electromagnetic Interference (EMI)

It is an important consideration in the design of cabling pathways. Providing physical separation from sources of EMI for these elements of the telecommunications infrastructure

inherently provides separation of their contents (e.g., cable and connecting hardware). Clearances shall be:

- 1.2 m (4 ft.) from large motors or transformers.
- 0.3 m (1 ft.) from conduit and cables used for electrical power distribution (400/230 volts).
- 12 cm (5 in.) from fluorescent lighting. Pathways should cross perpendicular to fluorescent lighting and electrical power cables or conduits.

NOTE: For additional clearance requirements, see TIA/EIA-569-E & NFPA 70.

5.7.4.2 Types of Horizontal Pathways

1) Horizontal pathways include:
   - Underfloor ducts (one-level or two-level), if used, require IT approval
   - Cellular floors, if used, require IT approval
   - Conduit
   - Cable Tray
   - Access (raised) floors
   - Ceiling zones and grids
   - Under carpet (restricted to use with flat, under carpet cables)

   Note:
   In some cases, buildings may require a combination of two or more of these systems to meet all distribution needs.

2) Refer to the BICSI TDMM latest edition, for the disadvantages, advantages and illustrations of each type of horizontal pathway.

5.7.4.3 Sizing of Horizontal Pathways

1) Usable Floor Space

   The usable floor space (also called “office space”) is considered to be the building area used by occupants for their normal daily work functions. Areas and spaces that have distribution systems (horizontal pathways and spaces) such as floor ducting, trays and conduit shall be considered usable floor space. For planning purposes, include these spaces and hallways, but not other common areas of the building (e.g., elevator, rest rooms, stairways, mechanical equipment rooms, and electrical rooms).

Note:

Waiting areas and entrance halls are quite large and are easily converted into office space during the life of a company building. Therefore, they are to be considered as "usable floor space".

2) Occupant Density

The standard floor space allocation used in an office environment is one individual work area (IWA) for every 10 m^2 (100 ft^2) of usable floor space. This is the maximum space size that shall be used for determining occupancy space numbers in a Saudi Aramco facility (e.g., community or business building and permanent or portable office). Smaller space sizes shall be used when determining occupancy spaces for buildings or offices with:

- High workstation saturation.
- High density of engineering work areas (cubicles).
- High density of Computer Aided Drafting (CAD) stations.
- High density of knowledge workers.
- Professional and other educational facilities.
- Or identified by proponent, DBSP (Design Base Scoping paper) or Scope of Work.

3) Cable Density

Two (2) horizontal cable runs per information outlet; and that for an enclosed IWA. The minimum configuration is consisting of two telecommunications outlets/connectors in the work area - one for telephony and the other for data. The pathway shall have a minimum of one-inch conduit design and shall allow for at least four cable runs per individual work area, to facilitate additions and changes as user needs evolve.

4) Cable Diameter

Table 16, lists typical ranges of cable diameter for recognized horizontal cabling media. These values are provided for planning purposes only. It is strongly recommended that the distribution designer check the actual diameter of the cable being used before determining pathway size requirements.

Table 14 – Horizontal Cable Diameter

Horizontal Cable Type	Typical Range of Overall Diameter

Four-pair 100-ohm UTP	0.36 cm to 0.61 cm (0.14 in. to 0.24 in.)
62.5/125 um Optical Fiber Cable	0.28 cm to 0.46 cm (0.11 in. to 0.18 in.)

5) Conduit Capacity

Table 15 provides cable capacity for conduits having cross-sectional areas ranging from 2 cm² (0.3 in²) to 82 cm² (12.7 in²), (refer to TIA/EIA-569-E).

Table 15 provides information on the maximum allowable communication cable capacity for horizontal conduits that have no more than two 90-degree bends (180 degrees total). Conduit fill percentages are also subject to the requirements of NFPA 70.

Table 15 – Conduit Capacity for Horizontal Cabling

Diameter Internal	Cable outside Diameter mm (in.)										
mm (in.)*	Trade Size inches	3.3 (.13)	4.6 (.18)	5.6 (.22)	6.1 (.24)	7.4 (.29)	7.9 (.31)	9.4 (.37)	13.5 (.53)	15.8 (.62)	17.8 (.70)
16 (.62)	½	1	1	0	0	0	0	0	0	0	0
21 (.82)	¾	6	5	4	3	2	2	1	0	0	0
27 (1.05)	1	8	8	7	6	3	3	2	1	0	0
35 (1.38)	1¼	16	14	12	10	6	4	3	1	1	1
41 (1.61)	1½	20	18	16	15	7	6	4	2	1	1
53 (2.07)	2	30	26	22	20	14	12	7	4	3	2
63 (2.47)	2½	45	40	36	30	17	14	12	6	3	3
78 (3.07)	3	70	60	50	40	20	20	17	7	6	6
90 (3.55)	3½	-	-	-	-	-	-	22	12	7	6

102 (4.02)	4	-	-	-	-	-	-	30	14	12	7

- Internal diameter values given in inches represent standard conduit trade sizes. Actual internal diameters may vary by as much as ⅛ inch.

6) The maximum conduit fills allowed by NFPA 70 are shown in Table 16. Other limitations apply (refer to NFPA 70).

Table 16 – Maximum Conduit Fills for Horizontal Cabling

Number of Cables per Conduit	Maximum Fill Allowed
One	53%
Two	31%
Three	40%

7) Determining Conduit Size

In the following Table 17 is a sample calculation to determine the size of a horizontal conduit, based on the preceding information and guidelines:

Table 17 – Determining Conduit Size

Step	Determining the Floor Space that a Conduit can Serve	Example (Ft/In.)
1	Measure the usable floor space to be served by the horizontal conduit.	100 m² (1000 ft²)
2	Divide the usable floor space by the maximum occupant density (required per individual work area [IWA])	100 m² (1000 ft²) ÷10 m² (100 ft²) = 10 IWAs
3	Multiply by the maximum number of cables per individual work area	10 IWA' s x 2 cables per IWA = 20
4	Determine the maximum diameter of the horizontal cable to be used.	0.61 cm (0.24 in)
5	Use the table in Para. 4.7.13.5 "Conduit Capacity" to determine the conduit size that is most suitable for holding a quantity of 30 cables with a diameter of 0.61 cm (0.24 in.)	63 cm (2½ in.)

8) Determining Raceway Size

The design capacities of raceways are typically based on a 28% fill factor. This figure is obtained by de-rating the raceway by 15% for each of two 90° bends. The resulting

70% is multiplied by the NFPA 70 requirement of 40% for conduits with more than two cables. The product of 70% and 40% is 28% (0.70 x 0.40 = 0.28).

This percentage fill is used to determine the total number of cables of a known cross-sectional area that may be housed in a raceway of a given size. See Section 4.8.20 “Overhead Raceways for Ceiling Distribution Systems” below.

Most raceways are provided with design guidelines, including fill factors. Verify which article applies in NFPA 70, Chapter 3, because different types of raceways have different requirements. See “raceway” definition in NFPA 70, Article l00.

9) Determining Duct Size

The minimum size feeder and distribution duct or tray (refer to BICSI for size - rectangular/square) shall be determined on a duct capacity of 6.5 cm^2 (1.0 in^2) of cross-section for each information outlet (not IWA). This relationship applies to both feeder and distribution ducts and is based on a minimum of two (2) cables per information outlet and at least one (1) information outlet per IWA.

10) Underfloor Duct System

i. Underfloor duct systems are a network of metal raceways embedded in concrete which facilitates the distribution of horizontal cables (i.e., between TR’s and work areas).
These types of systems require Saudi Aramco IT approval before being used for telecommunications infrastructures.

Ducts are rectangular and may be used in:

- Single, double, or triple runs.
- Combinations of large and small ducts, mixed to provide a larger or smaller capacity to match the needs of specific areas in a building.

Underfloor duct systems are made up of:

- Feeder (header) ducts, which carry cables from the TR to the distribution ducts.
- Distribution ducts, which distribute wires and cables from a feeder duct to specific floor areas.

Refer to the latest issue of the BICSI TDMM latest edition for additional information regarding Under Floor Duct Systems.

ii. Duct Distribution

Distribution ducts shall have preset inserts between 61-cm
(2-ft.) to 92 cm (3 ft.) centers.

Depending on the floor structure, ducts may be designed in one-level or two-level systems to:

- Distribute wires and cables from a feeder duct to specific floor areas.
- Provide access to wires and cables in a specific floor area.

iii. Junction Boxes

A maximum space of 18 meters (60 ft.) between junction boxes and other access points shall be maintained.

11) Design Requirements for Underfloor Ducts

Refer to the BICSI TDMM latest edition for general information in addition to the requirements listed below in this section.

5.7.4.4 Design Requirements for Underfloor Ducts

Refer to the BICSI TDMM latest edition for general information in addition to the requirements listed below in this section.

1) Feeder Duct

Feeder Ducts in a Cellular Floor System are the components that are used to bring the cable from TR's to the distribution cell or duct of a Horizontal Distributions system.

Notes:

1. *Feeder duct is often referred to as header duct, trench duct, trench header, jack header and telecommunications header duct. Trench duct is not the preferred choice of header duct to be used in Saudi Aramco for telecommunications infrastructure. Written approval shall be obtained from the supervisor of Communications Engineering & Technical Support Dept./Communications Coordination Division/Project Coordination Group when project proposals or detail design packages (e.g., design drawings, Scope of Work) specify the use trench ducts for telecommunications infrastructure (e.g., building premise distribution systems).*
2. *Trench duct is a metallic trough embedded in concrete that has removable plates level with the surround floor grade/level. It may have*

partitions for accommodate both telecommunications and electrical distribution cable.

3. *Trench duct shall only be used to connect the Cellular Floor Systems directly to TR (s) to complete the cable pathways between the distribution ducts (floor system) and TR (s). Short lengths of trench duct (known as Jack Header) shall not be allowed when connecting a quantity of distribution ducts together when there is no direct connection to a TR(s). For example; it is not permissible to place Jack Headers when an isolated floor area containing a floor duct system is required to be connected to another group of distribution floor ducts. Jack Headers shall not be allowed in the following floor spaces:*
   - *In areas that are subject to high pedestrian traffic.*
   - *In corridors that contain elevators.*
   - *Across or in front of main entrances or exits to buildings.*
   - *Across or in front of stairways (on any building floor level).*
   - *Across on in front of doorways where equipment will be carried or wheeled on floor surfaces frequently.*
   - *In areas where excessive loads will be expressed on floor surfaces.*

2) Feeder Ducts Size

Feeder ducts normally range from 49 cm^2 to 57 cm^2 (7.6 in^2 to 8.9 in^2) in cross-sectional area. A duct in this range serves an area of approximately 76–89 m^2 (usually 80 m^2) (800 ft^2).

3) Feeder Duct Capacity

There shall be 6.5 cm^2 (1 in^2) of cross-sectional area in a feeder duct for each IWA (10 m^2 [100 ft^2] of usable floor space) served by the duct.

4) Distribution Duct Sizes

Standard distribution duct size ranges from 21.3 cm^2 to 25.2 cm^2 (3.3 in^2 to 3.9 in^2) in cross-sectional area. Use larger distribution ducts range from 49 cm^2 to 57 cm^2 (7.6 in^2 to 8.9 in^2) when serving a floor area between 18 m and 24 m (60 ft and 80 ft) long.

The minimum allowable cross-sectional area of distribution duct for each IWA is 6.5 cm^2 (1 in^2).

5) Installing Distribution Duct

Space preset inserts at regular intervals, with insert makers approximately every 15 m (50 feet). Install and center the distribution duct between building module lines (space between joist) or at 5 foot to 6-foot intervals. Locate a single run of distribution duct within 45 cm to 61 cm (18 to 24 inches) of the outside wall.

Slab Thickness Requirements for Enclosing Duct for one-level shall be 13 cm (5 inches thick) and for two-level 18 cm (7 inches).

5.7.4.5 Telecommunications Room (TR) Considerations (for Underfloor Ducts)

1) Feeder and distribution ducts shall be physically linked to a TR either directly or through no more than one feeder duct. TR shall not be inter-linked or connected by making a transition in the floor feeder duct to an overhead arrangement of tray, duct or conduit. This shall be accomplished by having the floor feeder duct enter the TR at floor level. Ensure that the room is:

- Located centrally within the zone.
- Large enough for the required quantity of feeder ducts.

Note:

For more information on the termination of horizontal pathways in the Telecommunications Room, see BICSI TDMM standard for more information.

2) Duct Capacity

To maintain sufficient floor duct capacity, the maximum length of distribution floor duct shall not exceed 20m (60 ft).

Allow 6.5 cm^2 (1 in^2) of duct cross-sectional area for every 10 m^2 (100 ft^2) of floor area when designing floor duct systems.

3) Duct Capacity

To maintain sufficient floor duct capacity, the maximum length of distribution floor duct shall not exceed 20m (60 ft).

Allow 6.5 cm^2 (1 in^2) of duct cross-sectional area for every 10 m^2 (100 ft^2) of floor area when designing floor duct systems.

4) Determining Insert Spacing

If the standard insert spacing of 0.6 m (2 ft) is not adequate for a custom design, spacing may be determined by simply dividing the building module spacing by the number of inserts per module.

The recommended spacing is 38 cm (15 in.) or 50 cm (20 in.), with the inserts an equal distance from the module lines.

5.7.4.6 Designing a Two-Level Duct System

For the design and installation of an Underfloor Two-Level duct system refer to the latest issue of BICSI TDMM latest edition.

1) Cellular and Underfloor Floor Systems

a) Design and Installations

For the design and installation of Underfloor and Cellular floor systems (Distribution cells and Feeder [header] ducts) refer to the latest issue of the BICSI TDMM.

Coordinate cellular-floor planning with the building design agency (architect, structural engineer).

b) Systems under Carpets

In carpeted areas, all junction boxes must be accessible. Carpet openings which are cut when the carpet is installed shall:

- Ensure accessibility

And

- Shall blend into the carpet design and color

Junction boxes must be accessible through carpet openings. Carpet openings shall be firmly secured and not loose so as to impede pedestrian traffic or cause a safety hazard to pedestrians.

5.7.4.7 Distribution Conduit Systems

A conduit system consists of conduits radiating from the TR or junction box to the work area outlets in the floor, walls, or columns of a building.

This system is an underfloor or overhead conduit system which furnishes cable support for small buildings that will not have a high number of IWA' s or a high rate of moves, add and changes (MAC).

1) Suitable Conduits

- Rigid metal conduit (steel pipe).
- Rigid non-combustible polyvinyl chloride (if allowed by Building code).

2) Unsuitable Conduits

Flexible conduit is not suitable for pathways (such as metal flex conduit) and shall not be used in telecommunications conduit systems except to feed Individual Work Areas (IWA). The maximum length of flexible conduit is 1.2 m (4 ft) and may only be placed between the distribution raceway

(i.e., trunk, tray, conduit junction box) and riser (pole or conduit) to outlet box.

Refer to section 5.7.4.11, (Overhead Ceiling Raceway Method) below for additional information on the use of flexible conduit.

3) Acceptable Conduit Runs

Conduit runs shall be designed:

- No section of conduit shall contain more than 90° bends, or equivalent, between pull points.
- No section of contain shall be longer than 30 m between pull points. For more than 30 m in length, insert pull points or pull boxes is mandatory.
- Flexible metal conduit is not recommended, if it is used, the length shall be less than 6 m for each run .

4) Unacceptable Conduit Runs

Do not run conduit:

- On top of cellular floor cells.
- Crosswise to cellular floor cells.
- Through areas in which flammable material may be stored or handled (Hazardous Classified Area).
- Over or adjacent to:
  - Boilers.
  - Incinerators.
  - Hot water lines.
  - Steam lines**.**

Conduit shall not be used in lieu of header ducts:

- Between the distribution ducts and the TR.

OR

- To supplement the feeder capacity of the system.

Aluminum or thin-walled plastic conduit shall not be placed in concrete floors.

5) Conduit Cable Capacity

To ensure proper capacity for cabling, a one-inch (27 mm ID) conduit from a terminal or telecommunications room shall not serve more than one information outlet in offices, commercial sites/buildings, exhibition halls, dormitories, hospital rooms or offices.

The conduit size for horizontal cable must accommodate:

- Multiple building occupants.
- Cables placed at different times.

To determine the cross-sectional area of a cable or conduit from its nominal diameter, use the following formula:

Cross Sectional Area = (0.785) x (Diameter) ^{2}

6) Bend Radii for Conduits

The radius of a conduit bend shall be at least 10 times the diameter of the conduit.

7) Adapting to Conduit Bends

The following table provides information for adapting designs to conduits with bends.

An offset is to be considered the equivalent to a 90° bend when designing conduit systems.

Table 18 – Conduit Bends/Pull Box

If A Conduit Run Requires	Then
More than two 90° bends	Provide a pull box between sections with 2 bends or less
A reverse bend (between 100° and 180°)	Insert a pull point or pull box at each bend having an angle from 100° to 180°.
More than two 90° bends between pull points or pull boxes.	For each additional bend: De-rate the design capacity by 15% or Use the next larger size of conduit

8) Three Bends in Conduit

A third bend will be acceptable in a pull section without de-rating the conduit's capacity if:

- The run is no longer than 10 m (33 ft.).
- The conduit size is increased to the next trade size.
- One of the bends is located within 30 cm (12 in.) of the cable feed end. (This exception only applies where cable can be pushed around the first bend.)

9) Conduit Entering Telecommunications Rooms

A conduit that enters a TR shall:

- Terminate near the corner of the room where visible to allow for proper cable racking and splicing.
- Be terminated 10 cm (4 in.) above the finished floor.
- Be reamed or bushed and terminated as close as possible to the wall where the backboard is mounted (to minimize the cable route inside the room).

10) Completing Conduit Installation

After installation, all conduits shall be:

- Clean, dry, and unobstructed.
- Capped for protection.
- Labeled for identification.
- Sealed to comply with firestop requirements.

Equip all conduits (end to end) with a plastic or nylon pull line that has a minimum test rating of 90 kilograms (200 pounds). The end of each pull line shall be secured to avoid loosening the end section.

5.7.4.8 Access (Raised) Floors

For the design and installation of Access (Raised) Floors systems refer to the latest issue of the BICSI TDMM latest edition.

5.7.4.9 Conduit for Ceiling Distribution Systems

For the design and installation of Conduit for Ceiling Distribution Systems refer to the latest issue of the BICSI TDMM latest edition.

The method for distributing wires and pathways in a ceiling are acceptable provided the following conditions are met:

- Ceiling space is used only for horizontal cables serving the floor below, except for isolated cases to serve IWA in open areas; i.e., security and information desks in lobby areas.
- Ceiling access is controlled by the building proponent.
- Building proponent is aware of the responsibility for any damage, injury, or inconvenience to occupants that may result from technicians working in the ceiling.
- Cable pathways (pull boxes, trays, conduits junction points) are installed where they are fully accessible from floor area below and safe for cable installations and changes.
- Ceiling tiles are removable.

- Height of ceiling tiles or conduit are no greater than 3.4 m (11 ft.) above the finished floor.

1) Ceiling Zones Method

The usable floor area in the "Ceiling Zones" shall be divided into zones of 35 m² to 82 m² (365 ft² to 900 ft²) each. It is preferable that zones be divided by building columns.

Cabling to each zone may be placed in cable trays within the ceiling plenum area. Plenum-rated cable tray or raceway shall be required (refer to the NEC 300.22 and NEC 392.4 for restrictions on the use of cable trays). Zone conduit sizes are based on the "Conduit Capacity" Table 15.

Conduit sizes shall be based on placing a minimum of two (2) cables to each individual work (IWA) area of 10 m² (100 ft²). Cabling may also be enclosed in metallic conduits or raceways. The conduits or cable trays (when permitted) shall extend from the TR to the mid-point of each zone. Leave the end of the conduit or cable tray open when permitted by SAES-M-100 (Saudi Aramco Building Code). Cables shall be extended from the pathway to the top of the utility columns or wall conduit and down to work area outlet boxes.

2) Ceiling Home-Run Method Using Conduit

In a "Home Run" ceiling conduit system, place a continuous run of conduit from the work area outlet boxes to the TR.

Each home run conduit can serve from one to three outlet boxes, depending on the design and conduit size. For conduits that serve:

- One box, an inside diameter of 1.9 cm. (¾ in.) or greater is required.
- Two boxes, an inside diameter of 2.5 cm (1 in.) or greater is required.
- Three boxes, an inside diameter of 3.2 cm (1¼ in.) or greater is required.

Note:

The outlet box shall not serve as a pull point.

3) Ceiling Zone Restrictions

A zone conduit system may be allowed in an air plenum

ceiling if:

- Conduits terminate in junction boxes.

  AND

- Short runs of smaller conduit are extended from the junction boxes to the work area outlets.

4) Pathway and Cable Support

Ceiling conduits, raceways, cable trays, and cabling shall be suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight. The pathways shall:

- Have adequate support to withstand pulling the cables.
- Conduit access points must be located 15 cm (6 in.) to 45 cm (18 in.) above the T-bar and have clear vertical space.
- Have a minimum of 8 cm (3 in.) of clear vertical space from conduits, wires, and cables.
- Cable trays shall be located 15 cm to 30 cm above the top surface of the cable tray side rail.

Horizontal pathways and cables shall not rest directly on ceiling panels, framework (T-bars), vertical supports, or other components of the suspended ceiling.

5) Cabling without Conduit

Where building codes permit telecommunications cables may be placed in suspended ceiling spaces without conduit, ceiling zone distribution pathways may consist of:

- Cable Trays

  Notes:

  1. *There shall be a minimum of 76 cm (30 inches) of clearance (access space) for maintenance and operational work forces to one side of the cable tray continuously throughout the cable tray pathway, and extending to a height of at least 30 cm (12 inches) above the top surface of the cable tray side rail.*
  2. *Headroom depth* space of at least 30 cm (*12 inches) above the top surface of cable tray side rail.*
  3. *In small corridors of 6 feet or less are involved, a minimum access of 60 cm (24 in.) on one side of the cable tray shall be permitted.*

4. In a situation, when clearances cannot be achieved, HVAC ducting in particular. The cable tray design with a side opening shall be reviewed by the stakeholders (proponents and Saudi Aramco standard chairmen, SAES-T-916 and SAES-K-003 standards).

AND/OR

- Open-top Cable Supports (J-supports)

  Note:

  Generally, J-hooks should only be used where the available space does not permit the use of overhead cable trays, i.e., existing buildings. When used, J-supports shall be located a maximum of 122 cm (48 in.) to 153 cm (60 in.) apart to adequately support and distribute the cable weight. These types of supports shall not be used to support more than 10, 6.1 cm (0.25 in.) diameter cables.

Cable trays, conduit, and square trunking shall be provide where:

- Large quantities of cables (50 or more) convene at the TR and other areas.
- The ceiling area is used for an environmental air plenum.

Cabling without conduit shall only be used when prior approval has been obtained from the IT proponent organization.

6) Conduit to the Work Area

When running up to two four-pair 100-ohm UTP cables and two optical fibers to each work area, use one 5.3-cm (2-in.) conduit as a minimum for each zone ranging from 35 m^2 to 60 m^2 (350 ft^2 to 600 ft^2). For larger zones ranging from 60 m^2 to 90 m^2 (600 ft^2 to 900 ft^2), use 6.3-cm (2½-in.) conduit.

Note:

For conduits that contain more than one cable type, determine the size on the basis of the largest diameter cable to be used and the total number of cables it is expected to hold.

For the design and installation of “Utility Columns” (Distribution cells and Feeder [header] ducts) refer to the latest issue of the BICSI TDMM.

All utility poles shall be UL listed or equivalent for the specific application for which they are used.

5.7.4.10 Cable Tray Design for Ceiling Distribution Systems

1) Cable Tray Systems

Cable tray systems are commonly used as distribution systems for cabling within a building.

- Shall be rigid, prefabricated support structures that support telecommunications cables and cabling.
- Shall be installed to comply with:
  - NFPA 70, NEC Article 392 (latest Edition) requirements
  - SAES-M-100, Saudi Aramco Building Code
  - TIA/EIA-569-E
- Shall be installed and not use cable trays systems to distribute telecommunications and power cables together.
- Shall not be installed in ceiling areas (lock tiles, drywall or plaster) that are inaccessible. Exception is when a ceiling access opening is provided and overhead (above ceiling) walkway is provided within 300 mm of the cable tray.
- Should be installed in a corridor area that have an access for maintenance.
- Cable tray shall be marked and identified as specified in section 5.7.4.10 (1).

Note:

The inside of a cable tray must be clean and free of burrs, sharp edges, or projections which can damage cable insulation.

2) Cable Tray Fittings

The fittings used to change the direction or size of a cable tray includes:

- Elbows, Reducers, Crossovers, & Tees

3) Supporting Cable Trays

Support cable trays by installing:

- Cantilever brackets, Trapeze supports, & Individual rod suspension brackets.

Supports shall be placed so that connections between sections of the cable tray are between the support point and the quarter section of the span. A support shall also be placed within

0.6 m (2 ft.) on each side of any connection to a fitting.

Cable tray fills shall not exceed the manufactures listed capacity for a specified tray or the maximum load bearing capacity design.

Important Note:

Never use cable trays as walkways or ladders.

4) Marking and Grounding Trays

Metallic cable trays sections shall be bonded together and grounded to an approved ground source; i.e., TMGB, TGB's, etc.

5.7.4.11 Overhead Raceways for Ceiling Distribution Systems

1) Overhead Ceiling Raceway Method

Enclosed metal raceways used within the ceiling space to distribute cables shall:

- Use larger raceways to bring feeders into an area.
- Use smaller, lateral (distribution) raceways to branch off from the header and provide services to the usable floor space.
- Feed Individual Work Area (IWA) locations with a combination of conduit or exposed cable (if codes allow).

Note:

Flexible conduit [max. length 1.2 m (4 ft.)] may be used where conditions prohibit the use of standard EMT/RS conduit bends for connections to tele poles.

Use conduit or exposed cables from distribution raceways to:

- Utility columns, Partitioned walls, & Other service outlet locations.

When enclosed raceways and conduit are used in air plenums, plenum-rated cable shall be used.

Exception:

Special plenum rated cable shall not be required provided that the enclosed raceway is:

- *UL Listed or equivalent for use in a return air plenum*
- *That there are no openings in the raceway system at joints, interfaces with conduits or other pathways (e.g., conduits, raceway intersections and interfaces).*

2) Designing Ceiling Raceway System

a) Raceways shall be placed parallel to either the:
- Wall of the TR "OR"
- Longest outside building wall.

Note:

The ceiling raceway system shall be designed so that horizontal cables extending from the termination in the TR to the outlet are not more than the permanent link, 90 m (295 ft.) long.

b) Ceiling raceways shall be spaced on 5 m to 6 m. (16 ft. to 20 ft.) centers, starting at a point 1.2 m to 3 m (4 ft. to 10 ft.) from the outside wall.

Notes:

1. Install raceways on module lines, when possible.

2. The cable capacity of each feeder shall be greater than or equal to the anticipated work area requirements of the floor space it serves.

5.7.4.12 Termination and Location of Horizontal Cable and Pathways

The termination of all horizontal cabling and pathways systems into Equipment Rooms and TR's shall be done so that each pathway and cable:

- Enters the TR in such a way that it does not block or cover other equipment and cabling.
- Is secured mechanically or anchored so that movement does not occur during installation of cables.
- Shall be readily accessible to technician and installer.
- Allows for 20% expansion of the horizontal cabling system.
- Complies with all building codes (bonding & grounding, fire safety**).**

5.7.4.13 Outlet Boxes

1) Wall-Mounted Outlets Boxes

Design telecommunications outlets so that installations in a dry-wall, plaster, or concrete block wall will be at least 100 mm square by 57 mm deep (4 in. square by 2 ¼ in. deep) or (4 in. square by 2 1/8 in. deep).

Do not place outlet boxes back-to-back. This installation practice will allow:

- Noises to be transmitted between rooms.
- Possible transmission of heat and fire during a fire.

Always offset the box locations and connect them with conduit.

2) Cover Plates

Cover plates for wall-mounted outlets shall:

- Have two connector openings.
- Be installed on all outlet's boxes**.**

A 100 mm (4 in.) square box with a split two-gang cover allows careful concealment of a single male and female 25-pair connector.

3) Larger Outlet Boxes

A connector shall not be concealed in a 10 cm (4 in.) square box if:

- Conduits are multiplied in it.
- Key telephone system cables are looped through**.**

Use a larger box for these types of connector.

4) Mounting Wall Outlets Boxes

Wall outlets shall be securely mounted at least 150 mm above the floor. The work area telecommunications outlet box shall be located near an electrical outlet, within 1 meter and installed at the same height as the electrical outlet.

5.8 Firestop Systems

In this section this will provides guidelines for reestablishing the integrity of fire-rated structures and assemblies (e.g., walls, floors, ceilings) when these barriers are penetrated by:

Pipes, Cables, Conduits, Innerducts, Cable trays, & Ducts

The requirements stated in BICSI TDMM latest edition standard shall be followed. The additional requirements and exception as specified in section

5.8.1 to section 5.8.2 shall be complied.

5.8.1 All Firestop Materials shall be listed/qualified for the specific application that they are to be used as per BICSI TDMM. See more information regarding the design and installation for fire stopping.

5.8.2 Approved or listed fire stopping system shall be used as per Saudi Aramco standards, SAES-M-100.

5.9 Residential Cabling

The following sections which is stated in BICSI TDMM – latest edition shall hereby to comply, with additional requirements, exceptions and allowances as specified in section 5.9.1 to 5.9.9.

Note:

For cybersecurity requirements, it shall comply SACS - 033 Residential Building Connectivity Standard.

5.9.1 Electrical Power (same with BICSI)

Exception:

It shall have a minimum of one 250 V / 13 A (Per local government regulations and directives -SASO).

5.9.2 Telecommunications Cabling

5.9.2.1 Outlet Cable

Telecommunications outlet cable provides the transmission path from the DD to the telecommunications outlet. The length of each outlet cable shall not exceed the permanent link requirement, 90 m (295 ft.).

1) Recommended Cables (*same with BICSI*)

   Additional:

   a) Tri- or quad-shield is acceptable as replacement for Series 6 coaxial or commonly known as RG6.

   b) The following cable type is optional:

      - Optical fiber either Multimode or Single mode.

2) Telecommunications outlet/connector

   The telecommunications outlet connector shall be compatible with the media provided at that location (e.g., category 6a cable or higher with an outlet connector, 75-ohm Series 6 coaxial cable with an F-Type connector).

3) Equipment cords, patch cords and jumpers

   Equipment cords extend from the telecommunications outlet/connector to the terminal/equipment connector or from the Distribution Device (DD) connecting hardware to electronic equipment. Patch cords or jumpers may be used for interconnections or cross-connections at the Distribution Device (DD). For each channel, a total of 10 m is allowed for equipment cords and patch cords or jumpers.

5.9.2.2 Outlet Locations

A minimum of one outlet location for each service (data, voice, satellite TV) shall be cabled within each of the following rooms:

- Kitchen, Bedroom/s, Family room, Greeting room/s, and Den/study.

Additional data outlet locations in the family/great room should be provided so that no point along the floor line in any wall space is more than 7.6 m (25 ft.), measured horizontally, from an outlet location in that space.

5.9.2.3 Outlet and Cable Pathways

Pathways/conduits that conceal the cable shall be used as a means for placing outlet cable between a Distribution Device (DD) and the telecommunications outlet box or mounting bracket.

1) Pathways Planning

2) Pre-wire

Recommendations:

a) 300 mm (12 in) separation from power cables.

b) Pulling cable do not exceed:

- 110 N (25 lbf.) for balanced twisted-pair cable.
- 178 N (40 lbf.) for the Series 6 coaxial cable

c) Provide a minimum of 1 m (3 ft.) of cable slack at the distribution device and 0.25 m (8 in) at the information outlet.

d) Provide a 25 mm (1 in) minimum bend radius for balanced twisted-pair cable and the 75 mm (3 in) minimum bend radius for the Series 6 coaxial cable are maintained.

3) Single-dwelling Residence

A protective pathway such as conduit or bushings should be installed to minimize cable abrasion during installation, or damage that can be due to building vibrations. The interior unit walls and ceilings should be used for pathways. Exterior wall pathways may jeopardize cable installation by the nailing of siding through the sheathing, or the effects of heat during summer months in certain areas.

4) Multi-dwelling Residence

For multi-dwelling residence, refer to TIA 570-D Standard.

5.9.3 Security Systems Device Location

Pathways and conduits shall be installed in a star topology from each detector or sensor to the security panel location. In planning pathway/conduit design, the designer should consider the building design and the anticipated traffic patterns of the occupants as this will influence the program setting of arming and disarming delays, the positioning of sensors/detectors and surveillance cameras, and the provisioning of zones of protection. Installing security systems and peripherals (such as control panel, alarm panel, cables, and sensors/detectors) is not required.

5.9.4 Fire Alarm Systems

Comply with the requirements as a per NFPA 72and article 760 of the National Electrical Code (NEC).

5.9.5 Satellite/Digital TV

Satellite/digital TV system infrastructure (such as pathways/conduits, service boxes, and cables) shall be designed and installed in a star topology per Articles 820 and 725 of the NEC.

5.9.6 Telephone System

Telephone system infrastructure (such as pathways/conduits, service boxes, outlet/s, and cables) shall be designed and installed in a star topology per Articles 820 and 725 of the NEC.

5.9.7 Data Network

Pathways/conduits, pull boxes, patch panel and cables (Cat 5e or Cat 6/6a as specified in section 5.9.2.1 (1) shall be designed and installed in a star topology per Articles 820 and 725 of the NEC.

Proper design for future use of wireless access point shall be defined as per TIA/TSB-162B , Telecommunications Cabling Guidelines for Wireless Access Points. A minimum of one 3A, 250 V (as per SASO) nominal electrical outlet shall be provided within 0.5 m to connect the wireless device.

5.9.8 100-Ohm UTP Cabling

1) Bend Radius

In spaces with UTP terminations, cable bend radii shall not be less than four times the cable diameter for outlet cable.

2) Pulling Tension

The maximum pulling tension for a 4-pair 24-AWG UTP cable should not exceed 110 N (25 lbf).

3) Connecting Hardware

Only remove as much cable jacket as required to terminate connecting hardware in order to maintain the cable geometry. When terminating connecting hardware, preserve pair-twist as close as possible to the point of mechanical termination. For category 5e and category 6/6a cables, the amount of pair untwisting as a result of termination to connecting hardware shall be no greater than 13 mm (0.5 in). A minimum of 200 mm (8 in) of excess cable should be stored at each outlet.

5.9.9 75-Ohm Coaxial Cabling

Coaxial cables shall meet the requirements of SCTE IPS-SP-001 or ANSI/SCTE 15 2001 as specified up to a bandwidth of 1000 MHz for CATV or 2200 MHz for satellite.

1) Attenuation

Coaxial cable shall meet the attenuation requirements of Table 19. Listed plenum coaxial cables are allowed 20% degradation to these attenuation requirements.

Table 19 – Coaxial Cable Attenuation

Series	**6**	**11**
Frequency (MHz)	**Maximum (dB/100 ft) dB/100m**	
5	(0.81) 2.66	(0.38) 1.25
55	(1.60) 5.25	(1.03) 3.38
211	(3.08) 10.10	(2.01) 6.59
250	(3.36) 11.02	(2.20) 7.22
270	(3.50) 11.48	(2.30) 7.55
300	(3.70) 12.14	(2.43) 7.97
330	(3.89) 12.76	(2.55) 8.37
350	(4.01) 13.15	(2.64) 8.66
400	(4.30) 14.11	(2.83) 9.28
450	(4.58) 15.03	(3.02) 9.91
500	(4.84) 15.88	(3.19) 10.46
550	(5.09) 16.70	(3.36) 11.02
600	(5.34) 17.52	(3.54) 11.61
750	(6.00) 19.69	(3.99) 13.09
870	(6.50) 21.33	(4.33) 14.21
1000	(7.00) 22.97	(4.67) 15.32
1200	(7.70) 25.26	(5.13) 16.83

Series	6	11
Frequency (MHz)	**Maximum (dB/100 ft) dB/100m**	
1450	(8.60) 28.21	(5.61) 18.40
1800	(9.65) 31.65	(6.19) 20.30
2200	(10.70) 35.10	(6.78) 22.24

2) Bend Radius

The minimum bend radius for coaxial cable shall not be less than that recommended by the manufacturer. If no recommendation is provided, the minimum bend radius shall be 10 times the cable outside diameter under no-load conditions and 20 times the cable outside diameter when the cable is under a tensile load.

3) Pulling Tension

The maximum pulling tension of coaxial cable is dependent on the size and material of the center conductor. Copper-cladded steel (CCS) is stronger than bare copper. Pulling tension should not exceed the guidelines in Table 20 below.

Table 20 – Pulling Tension Guidelines

Center Conductor	RG-6 Series
Copper-Cladded Steel	334 N (75 lbf)
Copper	178 N (40 lbf)

NOTE:

When pulling a combination of different types of cable, limit the pulling tension to that of the minimum strength cable.

4) Characteristic Impedance

Characteristic Impedance shall be 75 ±3 ohms.

5) Coaxial Cable Connector

Series 6 cables shall be connectorized with F-Type connectors that meet the requirements of ANSI/SCTE 01 1996 R2001 (compression connectors are recommended). Hard-line cable shall be connectorized with an N-Type connector. F-Type or N-Type connectors for outdoor environments shall be sealed.

6) Termination

Each energized but unused coaxial connector that is part of the connecting block, splitter, amplifier or other similar electronic element shall be terminated with a 75-ohm impedance matching termination

device. In addition, each energized unused coaxial cable shall be terminated with a 75-ohm impedance matching termination device.

5.10 Grounding, Bonding, and Electrical Protection

Note:

Refer to SAES-T-795 standard, Grounding, Bonding, and Electrical Protection for Telecommunications Facilities. Furthermore, additional requirements and exception as specified in section 5.10.1 to section 5.10.8 shall also be complied.

5.10.1 Communications Grounding Practices

1) All communication ground shall always be required in one of the following:
   - Telecommunications entrance facility for sites with exposed cable (all Outside Plant cable within Saudi Aramco is classified “Exposed”).
   - Telecommunications Spaces.

     Note:

     It is the responsibility of the Distribution system designed to ensure that a suitable ground point (busbar) be made available in each of the facilities listed above.

2) The Communication bonding conductors shall be made of copper, copper alloy or tin-plated copper (for direct buried applications). It shall be made directly to the points being bonded and have minimum bending radius as follows:
   - 6 inch minimum for no. 6 AWG.
   - 12 inch minimum for 4/0 AWG.
   - 24 inch minimum for sizes greater than 4/0 AWG.

5.10.2 Equipment Grounding

Equipment manufactures rely on bonding, grounding, and protection of exposed circuits to limit the severity of surges that reach equipment. Three design methods that are acceptable for protecting large telecommunications equipment from the residual communications circuit surges are:

- Communications circuit isolation
- Equipment protection and bonding
- Isolated communications circuit grounding

  Note:

  When Isolated Communication Circuit Grounding is used to protect equipment from power surges, the length of isolated grounding conductor should be limited to the

most direct path to ground and avoid being attached to other components or equipment.

5.10.3 Receptacle Outlet Grounding

Receptacle grounds shall not be used as grounding or bonding substitute for telecommunications equipment (protectors, frames, cable, cable splices etc.).

Receptacles that are located in a TR or used by telecommunications equipment shall be bonded to the electrical building ground system.

Note:

Isolated ground receptacles (orange in color) shall not be used for the purpose of providing for an equipment ground.

5.10.4 Backbone Cable Protection

Telecommunications cable systems within Saudi Aramco are considered "Exposed." The following are to be applied when designing and constructing telecommunications systems:

- Electrical power cabling shall not be routed directly alongside communications cable (electrical cabling is usually in conduit, providing additional shielding).
- Route communications cable near the middle (core) of the building when practical to be surrounded by structural building steel that provides shielding.
- Avoid placing telecommunications cable near outer columns of the building. Usually, lightning currents from direct strikes tend to flow down through the outer columns of building structural steel.
- Telecommunications cable shall not be placed within 1.8 meters (6 ft.) of any lightning protection system components.
- Protect and ground all "Exposed Cables" that enters a building.
- A bonding conductor shall be installed along a non- shielded backbone cable pathway.

5.10.5 Backbone Cable Shield

Backbone cable shields shall be directly bonded to the nearest approved ground at each end.

Note:

Cable shields do not satisfy requirements for TBB.

5.10.6 Unshielded Backbone Cable

Unshielded backbone cable (shall be used between building floors) longer than 100 meters (328 feet) across, shall have a co-routed bonding conductor (CBC) installed as follows:

1) Route a 6 AWG copper conductor along each backbone cable route. (Ensuring a minimal separation between the conductor and the cables along the entire distance may satisfy equipment requirements for a CBC.)
2) Bond each end at the nearest approved ground in the area that the associated cables terminate or is spliced/cross-connected to other cables. Such bonding shall be done by using a busbar.

5.10.7 Splicing/Tie Cable Bonding

Some installations have shielded riser rated backbone cables that terminate in a TR with pairs feeding:

- Up and down to adjacent floors.

OR

- Horizontally to another TR serving a different area.

To equalize electrical potential as much as possible, additional bonding shall be included to the other floor or TR (s) that are being fed. The backbone cable bonding shall be extended as directly as possible to each approved floor ground (e.g., TGB, TMGB).

5.10.8 Shielded Cable Systems

Some indoor cabling systems rely on shielding as an integral factor in their signal transmission performance.

The cable shields are typically grounded through standard cable connectors to a connector/administration panel at each end, so that even after administration changes the cable shields are grounded at both ends.

The administration panels shall be bonded to the nearest approved ground with a direct minimum length grounding conductor. At the user terminal end, these cable shields are commonly terminated by the user terminal, which relies on the nearest power plug third wire (safety ground) instead of direct bonding.

Use manufacturer instructions and apparatus for terminating and grounding these cable types.

5.11 Administration

The Administration of Saudi Aramco telecommunications infrastructure shall be done as specified by BICSI TDMM. All cables in walls or other horizontal spaces shall be labeled. Cables that extend to outlet boxes must be covered with an outlet face plate and identified for telecommunications use only**.**

These records and as-built drawings shall be forwarded with the Mechanical Completion Certificate (MCC).

Records and drawings will serve paper-based administration systems in addition to those computer-based systems.

5.12 Labelling /Assigning Identifiers to Components of the ISP Infrastructure

Access to the telecommunications spaces such as, TER(ER), TR and closest shall be coordinated with the proponent

5.12.1 TER/TR Identifier (Door):

1) Warning signs (labelling) restricted shall be posted at the front door. The telecommunications spaces signage shall have the following information as follow, (both Arabic and English word), see figure below:

Typical Telecommunications Signage

Notes:

- *It shall be an industrial grade type sticker.*
- *It shall have a minimum sticker size of 15 cm x 35 cm*
- *It shall have a minimum size of lettering: 1-inch (2.5 cm)*

2) Office Buildings: Area ID, Building ID, TER/TR identifier

Example: UDH-B0001-R1310

DHA-B3304-E7TR02

Note:

TER/TR Identifier shall include floor and room location

3) Plant Facilities: Area ID, Plant ID, Building ID, TER/TR identifier

Example: UTH-WIP4-CCR-R100

Note:

Label it with phenolic tag or more advance signage is preferred, with text on labels shall be a font without serifs, be an upper case and minimum of 1-inche size, black letters with white background is preferred.

5.12.2 The following items listed below shall comply with TIA/EIA 606-C

1) Cabinet and Rack Identifiers

Non-grid coordinates scheme (row/position method) is preferred.

2) Cabinet and Rack Labeling

Each cabinet and rack shall be labeled on the front and rear in plain view with its coordinates from its location identifier. Preferred locations for labels are the top and bottom on a permanent part of the cabinet or rack.

Note:

Label it with phenolic tag or more advance signage is preferred, with text on labels shall be a font without serifs, be an upper case and minimum of 1-inche size, black letters with white background is preferred.

3) Patch Panel and Termination Block Identifier

a) Rack- or cabinet-mounted patch panel identifiers

b) Balanced twisted-pair patch panels

- Labeling for UTP patch panel with label fields
- Labeling for UTP patch panel without patch panel ID label fields

c) Optical fiber patch panels

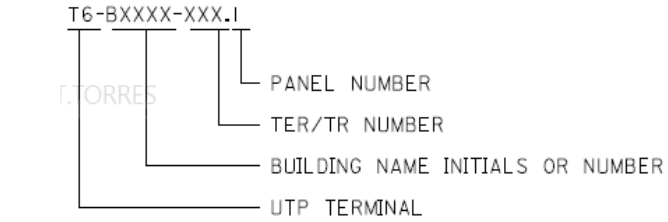
- Labeling of a fiber patch panel ignoring subpanels
- Labeling of a fiber patch panel with subpanels

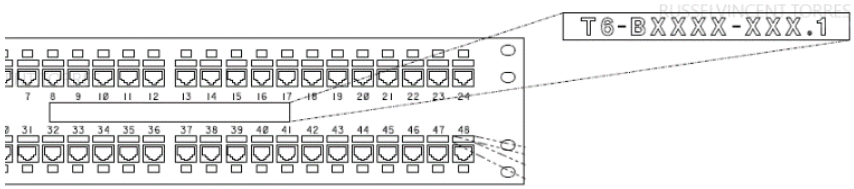
4) Frame- or wall-mounted termination block or patch panel identifiers
5) Patch panel port and termination block position identifiers
6) Cables between patch panels or termination blocks

5.12.3 Other Labelling Requirements:

1) Labeling Details for Horizontal Patch Panel

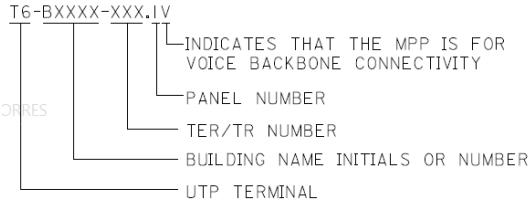
e.g. T6-BXXX-XXX.1 / T6-B0160-005.1

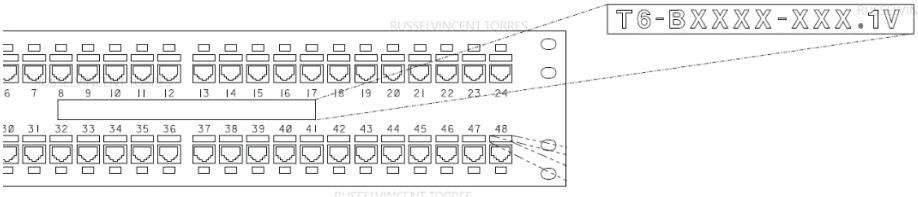




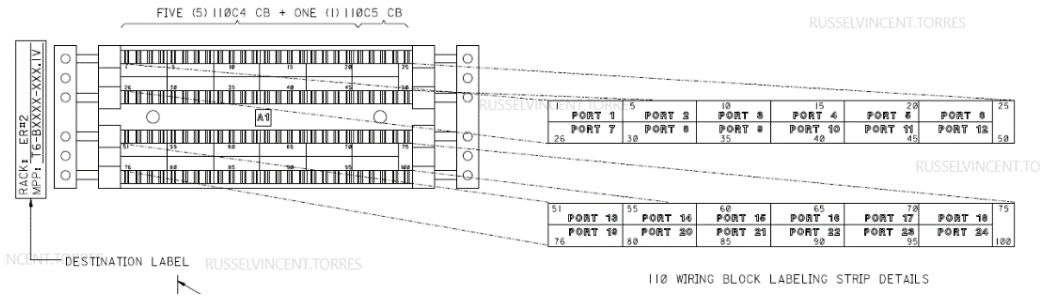
2) Labeling Details for Backbone Patch Panel

e.g. T6-BXXX-XXX.1V

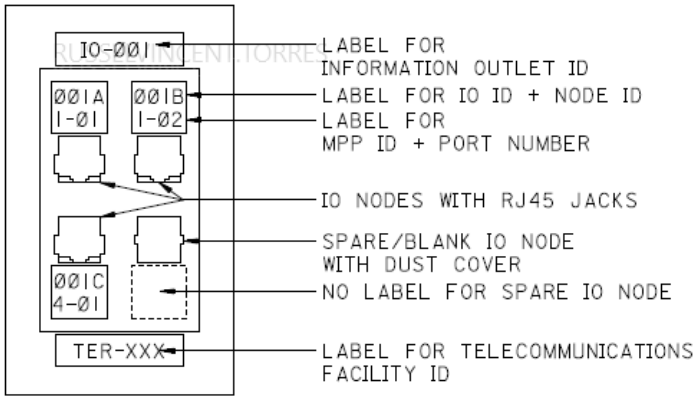




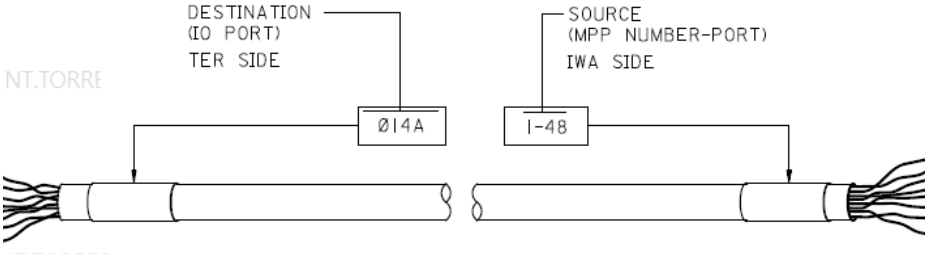
3) Typical 110 Block Labelling Strip



4) Typical Information Outlet (voice/data) labelling

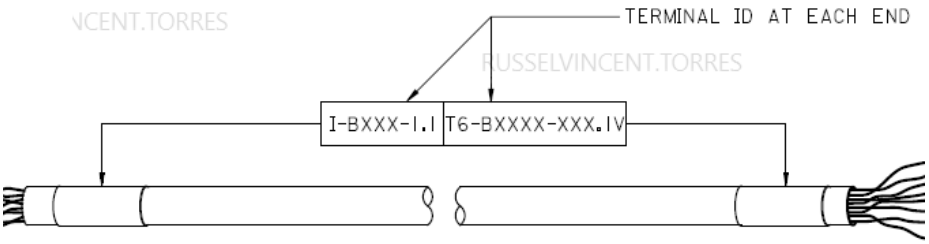


5) Horizontal Cabling (UTP) ID Labeling

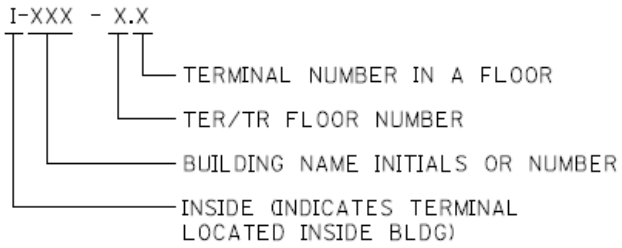


Note: To be attached at both ends of the cable

6) Tie-In Cable ID Labelling



Note: To be attached at both ends of the cable



7) Equipment Rack Labelling

Note:

Label it with phenolic tag or more advance signage is preferred, with text on labels shall be a font without serifs, be an upper case and minimum of 1-inche size, black letters with white background is preferred.

8) TMGB and TBB Labelling

- Label it with phenolic tag or more advance signage is preferred, with text on labels and shall be an upper case and minimum of 1-inche size, black letters with white background is preferred.
- Tag shall be on the wall next to the busbar and visible to end users, includes (if available) building number and bus-bar number .

9) Other Requirements: Pedestal Identifier

- Place a “Warning Underground Cable” label centered one inch below the top cover of the housing

- Use reflective lettering to show the pedestal identification number at minimum of 75 mm size, black letters.
- The label sequence as follow:

Example: **JAZ - IT PED** : First line

PED # 0000 : Second line

➢ First Line: Pedestal Marking

AREA ID:	Examples: DHR, ABQ, JAZ, UDH
IT PED:	Copper and FO cables for IT
PCCTV PED:	Process Closed Circuit Television
SCCTV PED:	Security Closed Circuit Television
PAGA PED:	Public Address and General Alarm
Non-IT PED:	FO cables Non-IT cables (if not defined)

➢ Second Line: PED # 0000 Sequence # (0001, 0002, 003, …)

6. Installation

6.1 Telecommunications pathways and cable system for customer premises are to be designed and installed in accordance with this standard and the latest BICSI Information Transport Systems Installation Manual.

6.2 Structured Cabling System (SCS) installation work should be done by qualified and certified work team consisting of at least a BICSI Installer Technician as follows, BICSI Installer Level II, BICSI Installer Level I, or equivalence, and additional manpower as required.

6.3 Equipment and patch panels shall be covered temporarily during installation to prevent collecting dust, flying parts and wire cuts.

7. Testing and Inspection

7.1 In-building cabling systems shall be tested per TIA/EIA TSB 67 and certified by installers who have been trained, qualified and certified to do these types of installations, see section 6.2. The outside plant and feeder/backbone cable(s) shall be tested to the performance requirements of SAES-T-624 for fiber optic cable and SAES-T-629 for copper cable.

Notes:

1. *All measuring and test equipment's must have a valid calibration date by the manufacturer or an approved agency by the manufacturer.*
2. *The primary field test parameters for installed 100-ohm 4-pair UTP cabling are:*
   a) *Wire map*
   b) *Length*

c) Insertion loss
d) Near-end crosstalk (NEXT) loss
e) Power sum near-end crosstalk (PSNEXT) loss
f) Equal-level far-end crosstalk (ELFEXT)
g) Power sum equal-level far-end crosstalk (PSELFEXT)
h) Return loss
i) Propagation delay
j) Delay skew.

7.2 Visual examination

Visual inspection of each cable run shall be made and may include but is not limited to:

1) Obvious damage to cable;

2) Separation from EMC sources;

3) Incorrect bend radii, and

4) Excessive cable length.

7.3 Outlet Identification

Outlet labeling is desired but not a requirement due to aesthetic considerations in the living space. Icons or labels may be mounted on the faceplate of each outlet, which denote the intended application for each outlet cable.

7.4 Distribution Device Identification

At a minimum, a label shall be provided within the distribution device denoting each cable run. Each cable run should be identified by room and wall locations. For example, B1-N could denote an outlet on the north wall of bedroom one. If outlets are not labeled, then consideration should be given to inclusion of simple floor plans at the distribution device that provide a graphic correlation between physical outlet locations and outlet designations.

7.5 Fiber Optic Cabling Test

Refer to SAES-T-624 for testing requiremenst.

7.6 Copper Cabling Test

Refer to SAES-T-629 for testing requirements.

7.7 The equipment and cabling installation shall be inspected by the Saudi Aramco Inspection Department to verify proper installation and compliance with the manufacturer's requirements. Additionally, cable and equipment shall be

inspected to verify that it has been installed to Saudi Aramco Engineering Standards, Industry Codes and detailed plans.

7.8 The Saudi Aramco Inspection Department must be notified a minimum of 48 hours in advance of required inspections or tests.

7.9 Test results shall be recorded and made available to the inspection and proponent departments for review. Test results including a summary sheet shall be submitted with the As-built documentation and the Mechanical Completion Certificate (MCC).

7.10 Inspection shall be done to verify that all excess materials and debris are removed from the telecommunications facility (ex., building, room, closet, cable trays, trench ducts and site).

Document History

16 June 2021	A major revision. Alignment with the international standards' latest revision (1) EIA/TIA and (2) BICSI, and added Saudi Aramco Cybersecurity standards, and requirement captured from the approved waiver's address to clearances (cable tray vs. HVAC ducting), and the water sprinkler system requirements inside telecommunication spaces. See the summary of changes above for more details.
15 February 2018	Merged SAES-T-570, Design Residential Telecommunication Infrastructure to this standard, and overlay SAES-T-916 with BICSI TDMM standard. Revised standard title to "Communications Building Pathways and Cable Systems" in alignment with BICSI TDMM standard. Value engineering session was conducted dated July 23-26, 2017.
9 September 2013	Minor revision to clarify ambiguity of some of the requirements.
10 February 2013	Revised the "Next Planned Update." Reaffirmed the content of the document, and reissued with no other changes.