Engineering Standard

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Communications Building Cable

Document Responsibility: Communications Standards Committee

Saudi Aramco DeskTop Standards

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Revised paragraphs are indicated in the right margin

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1 Scope

This standard covers mandatory requirements governing the engineering, design and installation of customer premises cable pathway and cable systems with the associate equipments used for voice and data network communications in Saudi Aramco facilities.

2 Conflicts and Deviations

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

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

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

Saudi Aramco Engineering Standards

SAES-A-105	*Noise Control*
SAES-A-112	*Meteorological and Seismic Design Data*
SAES-A-202	*Saudi Aramco Engineering Drawing Preparation*
SAES-B-006	*Fireproofing in Onshore Facilities*
SAES-B-014	*Safety Requirements for Plant and Operations Support Buildings*
SAES-B-019	*Portable, Mobile and Special Fixed Firefighting Equipment*
SAES-B-068	*Electrical Area Classifications*
SAES-M-100	*Saudi Aramco Building Code*
SAES-O-201	*Application of Security Directives*
SAES-P-103	*UPS and DC Systems*
SAES-P-111	*Grounding*
SAES-Q-001	*Criteria for Design and Construction of Concrete Structures*

SAES-T-018	*Telecommunications - Symbols, Abbreviations and Definitions*
SAES-T-151	*Communications dc Power System*
SAES-T-628	*Telecommunications - Underground Cable*
SAES-T-629	*Telecommunications Buried Cable and Wire*
SAES-T-631	*Communications Cable Terminals*
SAES-T-634	*Telecommunications - Cable Testing and Acceptance*
SAES-T-795	*Communications Facility Grounding Systems*
SAES-T-887	*Telecommunications: Electrical Coordination - Protection*
SAES-T-903	*Communications - Electrical Protection Outside Plant*
SAES-T-911	*Telecommunications Conduit System Design*
SAES-T-914	*Telecommunications Distribution Cable*
SAES-T-928	*Telecommunications - OSP Buried Cable*

Saudi Aramco Materials System Specification

09-SAMSS-097	*Ready-Mixed Portland Cement Concrete*

3.2 Industry Codes and Standards

American National Standards Institute

ANSI C2	*National Electrical Safety Code (NESC)*

Building Industry Consulting Services International

BICSI	*Building Industry Consulting Services International, TDMM (Telecommunications Distribution Methods Manual)*
BICSI	*Information Transport Systems Installation Manual*

Electronic Industries Association

TIA/EIA-568A	*Commercial Building Telecommunications Cabling Standard*
TIA/EIA-568-B.1	*Commercial Building Telecommunications Wiring Standard*
TIA/EIA-568-B.2	*Commercial Building Telecommunications Cabling Standard Part Two "Balanced Twisted-Pair Cabling Components"*

TIA/EIA-569-B	*Commercial Building Standard for Telecommunications Pathways and Space*
TIA/EIA TSB 67	*Transmission Performance for Field Testing of Unshielded Twisted Pair Cabling Systems*
J-STD-607-A	*Commercial Building Grounding and Bonding Requirements for Telecommunications*

International Electrotechnical Commission

IEC 60603-7	*Connectors for Frequencies below 3 MHz for Use with Printed Boards*
IEC 60874-10	*Sectional Specification for Fiber Optic Connector Type BFOC/2.5*
IEC 60874-14	*Sectional Specification for Fiber Optic Connector Type SCFOC/2.5*

International Organization for Standardization

ISO/IEC 11801 Ed.2:2002	*Information Technology – Generic Cabling for Customer Premises*

National Fire Protection Association

NFPA 70	*National Electrical Code (NEC)*
NFPA 101	*Life Safety Code*
NFPA 780	*Lightning Protection Code*

Underwriters Laboratories, Inc.

UL 444	*Standards for Safety for Communications Cables, Third Edition*

4 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.

4.1 General Information

4.1.1 Communications Distribution Designer

All building telecommunications cable system design must be done under the design authority of a valid/current BICSI Registered Communications

Distribution Design (BICSI RCDD) to ensure that a minimum level of competency has been provided in the telecommunications office building infrastructure and cable system design.

Commentary Notes:

- *This includes all design work done internally by Saudi Aramco organizations such as CE&TSD, Office Services, Community Maintenance and is applicable for new work, maintenance work, and/or renovations.*
- *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, CE&TSD/CCD/PCG, etc.) also is recommended to have a current/valid BICSI RCDD on staff as part of their review/acceptance process.*
- *No telecommunications office building infrastructure and/or cable system design shall be issued "for construction" without the related design work being done by a BICSI RCDD.*
- *If construction work has been undertaken without a design or using a design that was not done by a BICSI RCDD, the related Maintenance Group is under no obligation to accept such work as part of detailed design phase until such time as the situation has been made in full compliance of this standard.*

4.1.2 Review and Approval

When required in this standard, the review and/or approval authority for the proponent organization is, Saudi Aramco, IT/Communications Engineering & Technical Support Department, Communications Coordination Division, Projects Coordination Group or their representative.

4.1.3 Design/Construction Drawings

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

4.1.3.1 Data Required

The following information must be provided on construction drawings:

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) The telecommunication grounding system layout.

h) General Notes/Legend/Abbreviation.

4.1.3.2 Engineering Drawings shall be prepared and revised in accordance with all applicable Saudi Aramco standards, procedures and practices as well as those applicable international standards and practices approved by Saudi Aramco. Refer to SAES-A-202 (Saudi Aramco Engineering Drawing Preparation) for additional information.

4.1.4 Designing Telecommunications Distribution

The building/campus cable network designer shall identify and include in the design present and future needs 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.

4.1.5 Choosing the Transmission Medium for Horizontal Cabling

Category 6 UTP cabling and components providing a minimum of two cables per information outlet shall be used for all new installations.

4.1.6 Support Structure

All support structures shall be in accordance with BICSI TDMM Chapter 5. Support structures shall be designed to allow maximum flexibility and accessibility. The preferred support structure is Overhead and Cable Tray/pathways and 1" EMT Conduit.

Telecommunications support structures and equipment shall comply to the requirements of *SAES-B-006*, *Fireproofing in Onshore Facilities*.

4.1.7 Disaster 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.*

4.2 Entrance Facility

4.2.1 Entrance Facility and Termination Method

Telecommunications cable building entrances may be constructed by one of the following methods:

a) Underground entrances
b) Buried entrances
c) Aerial entrances (See Commentary Note)

Commentary Note:

Aerial type construction may be used for a temporary installation only.

4.2.1.1 Entrance Facility Room or Space

The entrance room or space is a component of the entrance facility that provides space for the entrance and termination of feeder and backbone cables (twisted pair copper and fiber optic). In some cases, the Entrance Facility (EF) room may be co-located with the Telecommunications Equipment Room (ER) and/or the Telecommunications Room (TR). When this occurs, the space requirements for the EF shall be in addition to the space required by the ER and/or TR. This space shall be sufficient in size to accommodate the equipment installation in addition to having space for future expansion.

4.2.1.2 Entrance Facility Room Requirements

a) Telecommunication entrance rooms shall have as a minimum one hour fire rated walls. These walls shall be continuous from the floor level to the permanent ceiling or roof level. The wall height shall not stop at the normal false or drop ceiling levels.

b) A Telecommunications Entrance Facility room fitted with a combination door lock with a keypad and key shall be provided for buildings exceeding 2000 m^2 (20,000 ft^2) of usable floor. Buildings having 10,000 m^2 (100,000 ft^2) or more of usable floor space shall have a dedicated entrance facility room.

c) Buildings with less than 2000 m^2 (20,000 ft^2) may use a Telecommunications Room or Telecommunications Equipment Room to accommodate the entrances of

cables provided that the conditions of paragraphs 4.2.1.4, 4.2.1.5, 4.3.1 and 4.4.1.3 are met.

d) Cable splices shall not be mounted or placed in overhead cable trays. Cable splices shall be accessible to cable technicians at floor level.

e) Entrance Facility Room shall not have water lines, drains, etc., located inside the room or in the overhead ceiling.

4.2.1.3 Entrance Facility Design Considerations

a) When designing or constructing an entrance room or space the following shall be accomplished:

1. Maintain the same size pathways between the entrance point and the entrance room or space.

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

3. Be located in an area that is dry and not subject to flooding.

4. Be as close as practicable to the vertical backbone pathways.

5. Be free from being used as a storage room/area for any materials (e.g., equipment, cables, janitorial supplies/tools, chemicals, equipment, office supplies)

6. Be secure by having a combination lock with a keypad and key fitted on the access door (s).

b) A vertical mounted wall frame protector shall be provided for buildings exceeding 6,000 m^2 (60,000 ft^2) of usable floor space. This applies to facilities having more than a 600 pair copper cable building terminal. Free standing frames may also be considered for cable terminations.

4.2.1.4 Terminating Space for Entrance Facilities

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

b) A transition splice point from outside plant non-fire rated to indoor fire rated cable shall be made to limit the exposed non-fire rated cable to 15 m or less.

c) 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.)

Commentary Notes:

- *80 cm 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.*

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

e) One of the following actions shall be taken if a situation requires more than 15 meters (50 feet) of entrance cable between the entry point and the termination point:

1. Relocate the cable entrance point so that it is within 15 meters (50 feet) of the termination point.
2. Relocate the termination point so that it is within 15 meters (50 feet) of the cable entrance point.

f) Wrap the short lengths (15 meters or less) of non-fire rated entrance cable with fire rated tape from where the cable exits the entrance conduit up to the termination/transition splice closure.

g) On a bearing or permanent wall.

h) Physically protected. Larger terminations require a separate room set aside for the use of telecommunications purposes (voice, data, broadband etc.) only. Buildings 100 m^2 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)

i) Easily accessible at all times.

4.2.1.5 The following tables specify the minimum allowable space for all telecommunications entrance rooms or space for splice cases, equipment and associated cross-connections.

Table 1 – Minimum Termination Wall Space

Usable Floor Space		Wall Length	
m^2	ft^2	mm	in.
500	5000	1230	48
1000	10000	1230	48
2000	20000	1230	48
4000	40000	2460	96
5000	50000	2460	96
6000	60000	2460	96

Note: The above information is based on terminations and equipment mounted on 2.5 m (8 ft) high wall.

Table 2 – Minimum Equipment and Termination Room Space

Usable Floor Space		Room Dimensions	
m^2	ft^2	mm	ft
7,000	70,000	3660 X 2012	12 X 6.6
10,000	100,000	3660 X 2012	12 X 6.6
20,000	200,000	3660 X 2750	12 X 9
40,000	400,000	3660 X 3970	12 X 13
50,000	500,000	3660 X 4775	12 X 15.6
60,000	600,000	3660 X 5670	12 X 18.6
80,000	800,000	3660 X 6888	12 X 22.6
100,000	1,000,000	3660 X 8412	12 X 27.6

Note: The above information is based on twisted pair copper conductor terminations and equipment mounted on free standing and or vertical racks. Space adjustments are allowed when fiber optic feeder cable is utilized.

4.2.1.6 As a minimum each Telecommunications Entrance Facility or space shall be provided with the following:

1. An approved ground source. Refer to paragraph 4.7.8.1 "Grounding Choices" below for specific bonding and grounding information and J-STD-607-A, (Commercial

Building Grounding and Bonding Requirements for Telecommunications).

2. Provide wall space for current and future building ultimate cable mounting, splicing (vertical or horizontal mounted splice cases) and termination.

3. A minimum of two walls covered with rigidly fixed 19 mm (¾ in.) thick x 2440 mm (8 ft) high trade, size A-C plywood, capable of supporting attached equipment and painted with two coat of fire retardant paint on all sides.

4. Lighting that measures a minimum of 500 Lux (50 foot candles) at 1 meter above the finished floor level, and mounted a minimum of 2600 mm (8.5 ft) above the finished floor level.

5. Access door that measures a minimum of 910 mm (36 in.) wide and 2000 mm (80 in.) high, fitted with a combination lock with a keypad and key. The door should open outward (where Building Code permits).

6. Open ceiling, (no false ceiling permitted).

7. Floors, walls and ceiling treated to eliminate dust. Finished in a light color to enhance room lighting.

8. Convenience duplex 230volt outlets spaced at 1.8 m (6 ft) intervals around the perimeter walls at a height of 300 mm (12 in.).

9. At least one emergency power duplex outlet if it is available to the building.

10. Be free from water pipes, drains, hot water heaters, etc., or the possibility of flooding.

11. Have a minimum of one hour fire rated wall.

12. Buildings larger than 9,300 square meters (100,000 ft^2) must provide a dedicated room for entrance facilities.

13. Cable splices shall not be mounted or placed in overhead cable trays or below raised floors. Cable splices shall be accessible to cable technicians at floor level.

4.2.2 Underground Entrance

4.2.2.1 Sizing Underground Entrance Conduits

The number and size of conduits extended into a building shall be based on the number and type (twisted pair copper and fiber optic cables) of telecommunications circuits which will ultimately be required in the building. For conduit sizing purposes, assume a minimum of one entrance cable pair (copper conductor) will be provided for each 10 m² (100 ft²) of usable office space. With this assumption, the minimum number and size of conduits specified in Table 3 shall be installed:

Table 3 – Sizing Entrance Conduit

Estimated Entrance Pairs & Square Meters of Usable Office Space	Minimum Required Conduits for Copper Cables and Copper Cable with Optical Fiber Cables
1-25 (up to 200 m^2)	2 (One 4-inch conduit plus 1 spare) *
26-1,000 (201-9,000 m^2)	3 (Two 4-inch conduits [one equipped with three 1-inch subduct/innerduct] plus 1 spare)
1,001-2,000 (9,001-18,000 m^2)	4 (Three 4-inch conduits [one equipped with three 1-inch subduct/innerduct] plus 1 spare)
2,001-3,000 (18,001-27,000 m^2)	5 (Four 4-inch conduits [one equipped with three 1-inch subduct/innerduct] plus 1 spare)
3,000-5,000 (27,001-45,000 m^2)	6 (Five 4-inch conduits (one equipped with three 1-inch subduct/innerduct) plus 1 spare)
5,001-7,000 (45,001-63,000 m^2)	7 (Six 4-inch conduits (one equipped with three 1 inch subduct/innerduct) plus 1 spare)
7,001-9,000(63,001-81,000 m^2)	8 (Seven 4-inch conduits (one equipped with three 1-inch subduct/innerduct) plus 1 spare)

Notes:

1. A minimum of one additional 4-inch conduit shall be provided for each additional 25-1800 entrance pairs (90-16,200 m²).
2. The above listed number of conduits list only minimum requirements. The communications proponent may specify additional conduits for other needs, such as video, tie cables, dual feeds and other miscellaneous requirements.
3. A spare conduit shall always be left vacant for maintenance and repair operations.
4. If 2 (One 2-inch conduit plus 1 spare) plan to be install, a written approval from IT proponent organization shall be obtained.
5. All entrance conduits (including subducts/innerducts) shall be equipped with pull ropes.
6. All conduits (including subducts/innerducts) shall be sealed in accordance with SAES-T-628 "Telecommunications – Underground Cable".

4.2.2.2 Buildings with Only Fiber Optic Cable Entrances

Buildings that have been identified as only having fiber optic cable services provided to them will not be required to comply with the requirements of Table 3. However, there shall be an engineering review conducted with IT to verify the ultimate number of conduits that are required to provide service to the facility. Additionally, there shall always be one spare conduit provide for maintenance purposes. Conduit that contains fiber optical cable shall be provided with subduct.

4.2.2.3 Dual Entrances

For information regarding dual entrances refer to the latest issue of the BICSI TDMM. DBSP shall determine when a building shall require dual entrance.

4.2.2.4 Conduit Design and Installation

Outside plant conduit design and installation shall be done to SAES-T-911, "Telecommunications Conduit System Design" requirements.

4.2.3 General Requirements for Underground Entrances

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

4.2.3.1 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.

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

4.2.3.3 Sealing Entrance Conduit inside a Building

All building entrance conduits shall be plugged or sealed in accordance with the requirements of SAES-T-628 and SAES-T-914. Conduits shall be sealed at all times or resealed immediately after cables are installed.

4.2.3.4 Sizing Indoor Pull Boxes

Use the following table to determine the minimum pull box size when constructing a pull box for entrance conduits:

Table 4 – Sizing Indoor Pull Boxes for Entrance Conduits

Maximum Trade Size of Conduit Inches	Width	Size of Box Length	Depth	For Each Additional Conduit Increase Width
2.0 in.	203 mm (8 in.)	914 mm (36 in.)	102 mm (4 in.)	127 mm (5 in.)
3.0 in.	305 mm (12 in.)	1,219 mm (48 in.)	127 mm (5 in.)	152 mm (6 in.)
4.0 in.	381 mm (15 in.)	1,524 mm (60 in.)	203 mm (8 in.)	203 mm (8 in.)

Notes:

1. Pull boxes must be equipped with hinged, lockable covers.
2. Boxes shall be made of material inherently resistant to corrosion or shall be suitably protected, both internally and externally, by enameling, galvanizing, plating, or other means.
3. If constructed of sheet steel, the metal thickness shall not be less than 0.053 in (1.35 mm) uncoated.

4.2.3.5 Indoor Conduit Bends

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

4.2.3.6 Choosing Pull Points

Refer to SAES-T-911 "Telecommunications Conduit System Design" for determining the pull point locations for the placement of entrance cables.

4.2.3.7 Reaming Conduit

All ends of metallic conduit shall be reamed and bushed.

4.2.3.8 Preventing Conduit Shearing

Conduits/sleeves through foundation walls must extend to undisturbed earth to protect against shearing.

4.2.3.9 Encasement

Consider using reinforced concrete at any location subject to extreme stress, (refer to SAES-Q-001, Criteria for Design and Construction of Concrete Structures and 09-SAMSS-097, Ready-Mixed Portland Cement Concrete).

Refer to SAES-T-911 (Telecommunications Conduit System Design) for design and construction information regarding conduit and manhole systems.

4.2.4 Buried Entrances

Direct buried entrance conduits shall be encased in concrete. Direct buried entrance design and construction shall be done in accordance to SAES-T-629 (Telecommunications Buried Cable and Wire), SAES-T-911 (Telecommunications Conduit System Design) and SAES-T-928 (Telecommunications - OSP Buried Cable). Design and Construction methods shall not be permitted with electrical power facilities in Saudi Aramco. Refer to SAES-T-903 (Telecommunications Outside Plant Electrical Protection and Grounding and SAES-T-928, Telecommunications - OSP Buried Plant) for more information regarding direct buried cable design and installation.

- Clearing Foundation Landscaping

  All buildings' entrance conduits, which are stubbed out for buried cable entrances, shall extend a minimum of one meter beyond the foundation or landscaping border and shall be properly sealed (refer to paragraph 4.2.3.4 above).

4.2.5 Outside Building Terminals Pedestals and Cabinets

Refer to the latest issue of the BICSI TDMM and SAES-T-631 (Communication Cable Terminals) and SAES-T-887 (Electrical Coordination-Protection at Power Plants and Radio Stations) and SAES-T-903 (Outside Plant Electrical Protection and Grounding) for information regarding the design and installation of building terminal pedestals and cabinets.

4.2.6 Other Telecommunications Entrance Facility Considerations

4.2.6.1 Planning for Campus Arrangements and Core-Building Arrangements

Refer to the latest BICSI TDMM for information regarding,

"Campus Back Bone Systems."

4.2.6.2 Inter Building Pathways

Buildings as described in paragraph 4.2.6.1 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 two (2) four (4) inch PVC conduits. This requirement is in addition to the normal building Telecommunications Entrance Facility requirements. Both pathway ends shall terminate in telecommunications Equipment Rooms (ER), Telecommunications Room (TR) or entrance facilities of the connected buildings. All conduit design and construction shall comply with SAES-T-911, (Telecommunications Conduit System Design).

4.3 Telecommunications Equipment Rooms

4.3.1 A telecommunications Equipment Room(ER) is a special purpose room that shall provide space and maintain an operating environment for:

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

4.3.2 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 Equipment Rooms or TRs that provide network connectivity.

4.3.3 Design

An Equipment Room may serve an entire building; some building designs may require more than one equipment room to provide one or more of the following:

- Separation of communications and computer equipment.
- Redundant facilities and disaster recovery strategies.
- A separate facility for different proponents in a multi-proponent building.
- Other proponent or communications needs.

The telecommunications Equipment Room may also include the Telecommunications Entrance Facility Room and/or a Telecommunications Room functions. Space shall be added to the initial size of the ER that is equal to the space requirements of the ER, EF and TR functions when they are to be placed in the ER. This is required to accommodate the additional space requirements of the telecommunications Entrance Facility (refer to paragraph 4.2.1.5 for space requirements) and TR function.

Telecommunications equipment room design shall be based on the following:

TIA/EIA-568-B.1 *Commercial Building Telecommunications Wiring Standard*

TIA/EIA-569-B *Commercial Building Standard for Telecommunications Pathways and Spaces*

The design specification for a telecommunications equipment room shall include:

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

4.3.4 Locating the Telecommunications Equipment Room

4.3.4.1 Major Considerations

The following factors shall be considered and reflected in the final design when choosing the location for an equipment room:

- Space requirements for equipment.
- Access to horizontal and backbone cable pathways.
- Building facilities

- Access to the building entrance facility.
- Communication IT proponent requirements.
- As close as possible to an approved ground source (refer to Section 4.7 below, Grounding, Bonding and Electrical Protection). Refer to Section 4.2 (Telecommunications Entrance Facility and Termination) when the telecommunications equipment room includes the entrance facility.

Commentary Note:

Final design shall be reviewed and approved by the IT proponent organization.

4.3.4.2 Provide Adequate Equipment Space

The floor space shall allow the telecommunications equipment room to provide sufficient space for the initial installation, future growth (minimum 10%) and changes.

Commentary 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.

4.3.4.3 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 TR function is included).
- Is accessible to cable routing pathways.

4.3.4.4 Access to the Telecommunications Equipment Room

The access door to Telecommunications Equipment Rooms (TER) shall be designed/constructed in such a manner that the access door opens to an internal corridor of an environmentally controlled building.

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 to the Telecommunications Equipment Room access door and access security is maintained.

4.3.5 Space Allocation and Layout

4.3.5.1 Working Clearances

A clear work space of 91 cm (36 in.) shall be provided in front and 76 cm (30 in.) to the rear of terminals and equipment mounted on floor racks and floor support structures. When an equipment rack(s) (e.g., 19 inch/48 cm) is mounted parallel to an equipment room wall a clearance space of 15 cm (6 inches) shall be maintained between the outer edge of the rack (s) and the equipment room wall.

A minimum clearance of 30 cm (12 in) shall be provided between the top rail of cable trays and ceilings. Additionally, 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 pathways.

4.3.5.2 Work Location Space

Work location space will be provided as required in the telecommunications equipment room for system administrators and other operations and maintenance personnel. This includes space for workstations, displays, desk and printers.

4.3.5.3 Equipment Installation Methods

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

4.3.5.3.1 Wall Mounting

In this method, a fire retardant rigid plywood (19 mm x 2440 mm) backboard (or non-fire rated rigid plywood painted with two coats of a non-conductive, fire retardant, white paint) is permanently attached to the wall.

4.3.5.3.2 Floor Standing Racks, Frames, or Bays

Floor space is to be allocated in rows.
For equipment racks installation provide a minimum

space of 400 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 J-STD-607-A "Commercial Building Grounding and Bonding Requirements for Telecommunications."

4.3.5.3.3 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 J-STD-607-A. Raised floors are required for equipment cabinets which require air conditioning from the bottom of the cabinet.

Commentary Note:

NEC Article 392 and NEC Sections 800-52 and 800-53 also apply to the equipment installation. SAES-T-795 (Communications Facility Grounding Systems) shall also apply when there is a major communications switch located in the telecommunications equipment room.

4.3.5.4 Cable Installation Methods

The following are acceptable installation methods:

4.3.5.4.1 Sleeves

This method is used to route cable through building floors and walls. (See paragraph 4.6.4.2 below for detailed information).

4.3.5.4.2 Conduits

This method may also be used for routing cable through floors and walls. Bushings shall be placed on the ends of metallic conduit to protect cable sheaths from damage.

4.3.5.4.3 Overhead Cable Trays

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 (2002 Edition) and TIA/EIA-569-B.

Commentary Note:

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

4.3.5.4.4 Raised Floor

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

4.3.6 Electrical Requirements

4.3.6.1 Power Requirements

Each equipment rack shall be provided with a minimum of two (2) dedicated 20 AMP, 230 volt ac duplex electrical outlets, each on separate circuits for equipment power. 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. Future power requirements shall be considered when designing equipment rooms.

Commentary Notes:

1. Additional outlets (power stripes) 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.

2. *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).*

3. *Power panels for dedicated electrical service shall be provided in TERs. Lighting fixtures shall not be powered from the same electrical distribution panel as the telecommunications equipment in the room.*

4.3.6.2 Maintaining Power Quality

Since telecommunications equipment can be very sensitive to power abnormality, dedicated feeder/branch circuits and power conditioning shall be provided. Allocate space for power conditioning, backup, or standby systems as required for the equipment.

4.3.6.3 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.

Caution:

Design all battery rooms so that they are properly ventilated per Section 4.3.5 above.

4.3.6.4 Continuous HVAC Operation

A stand-alone HVAC unit with independent controls shall be provided for the telecommunications equipment room when the building's air conditioning (HVAC) equipment cannot ensure continuous operation (24 hours per day, 365 days per year).

4.3.6.5 Typical Telecommunications Equipment Room Requirements

The HVAC requirements of each piece of equipment must be considered. The table below lists the equipment requirements and shall be considered minimum for all equipment rooms:

Table 5 – Equipment Room HVAC Requirements

Environmental Factor	Minimum Requirements
Temperature range	18 to 24°C (64 to 75°F)
Humidity range relative	30 to 55%
Heat dissipation hour	750 to 5,000 BTUs per cabinet

Each telecommunications equipment room shall have an independent HVAC system controls (temperature and humidity) to control its own environment.

The design package shall include information identifying the maximum expected heat dissipation from each piece of equipment. Additionally, the 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.

4.3.7 Structural Requirements

4.3.7.1 Wall

Telecommunications equipment room walls shall:

- Extend from the finished floor to the structured roof or ceiling level.
- Be covered with two coats of a non-conductive, fire-Retardant white paint.
- Be fire resistant rated.

Communication equipment rooms shall have as a minimum one hour fire rated walls. These walls shall be continuous from the floor level to the permanent ceiling or roof level. The wall height shall not stop at false or drop ceiling levels. Overhead routing of other utilities through the telecommunications equipment room space shall be avoided to prevent obstruction to communication equipment. Refer to NFPA 101 (Life Safety Code), SAES-B-014 (Safety Requirements for Plant and Operations Support Buildings) and SAES-M-100 (Saudi Aramco Building Code) for conditions that require a higher fire rated wall for these types of rooms.

4.3.7.2 Floor

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 in telecommunications equipment rooms. This shall be applied when designing for a new facility and upgrading or rehabilitating an existing one. 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 be used:

- High-pressure laminate tile
- Vinyl or other durable tile

4.3.7.3 Ceiling

Ceilings shall be at least 2.6 meters (8 feet, 6 inches) high to provide space over the equipment frames for suspended racks and cables. There shall be no false or drop ceilings in telecommunications equipment rooms. This is required so that free access can be made to place horizontal support structures and cabling and to decrease dust accumulation from suspended ceiling panels.

4.3.7.4 Access

A minimum of 914 mm (36 in.) width door access to the equipment room shall be provided. The access route shall be adequate for future equipment changes. If there will be specific requirements for oversized equipment, then double access door shall be provided.

4.3.7.5 Security

A secure room (Entrance Facility, Equipment Room, and Telecommunications Rooms) shall be fitted with a combination door lock with a keypad and key.

Commentary Note:

Telecommunications Equipments Rooms shall be fitted with a card reader security system when they contain telephone switches (e.g., PABX's, RLU's, RSU's), and wireless transmission systems.

4.3.8 Miscellaneous Requirements

4.3.8.1 Lighting

Telecommunications equipment rooms shall have adequate and uniform lighting with a minimum intensity of 50 footcandles (LM/ft^2) measured 91 cm (36 inches) above the floor level. Light fixture positions shall be coordinated with the equipment layout, and overhead cable trays to ensure that lighting is not obstructed to any area in the equipment room.

4.3.8.2 Fire Protection

Fire protection requirements shall be in accordance with SAES-B-014. The detector shall have a remote light extended from its circuit to a location outside the main entrance door. This is required so it may be identified as the equipment room detector when activated.

Portable fire extinguishers or fire extinguishing systems shall be provided in accordance with SAES-B-019 (Portable, Mobile and Special Fixed Firefighting Equipment). Also, refer to SAES-M-100 (Saudi Aramco Building Code) for additional information.

Coordinate the placement of fire protection systems with the equipment layout to avoid obstructing access to the alarm or other protective measures.

4.3.8.3 High-Temperature Alarm Operation Requirement

Telecommunication Equipment Room (TER) shall be equipped with High-temperature sensor with alarm indication relayed to the Networks Operations Center (NOC).

4.3.8.4 Exposure to Unsatisfactory Materials

The equipment room shall not be used to store corrosive, combustible or explosive substances. Examples of prohibited substances include:

- Cleaning chemicals such as acid, ammonia, and chlorine.
- Office and computer supplies such as paper and copier/printer fluids.

- Grounds keeping chemicals such as fertilizers, insecticides, and salt.
- Combustible dust or other airborne particles.
- Petroleum products (fuels).

4.3.8.5 Room Usage

Telecommunications equipment rooms shall not be used as storage rooms or as access to storage rooms. The equipment room must be kept clear of all items not related to its operation or function.

4.3.8.6 Noise Levels

Noise levels in telecommunications equipment rooms shall comply with SAES-A-105, (Noise).

4.3.8.7 Sensitive Equipment and EMI

Telecommunications circuits and equipment shall not be located next to electrical devices or equipment that can cause Electromagnetic Interference (EMI). Separation from electrical circuits, motors, transformers (Equipment that produces EMI) shall be maintained such that sensitive equipment and its associated circuits shall not be influenced by EMI. Likely sources of EMI, which must be avoided, are heavy-duty electromechanical equipment (e.g., copiers, door openers, elevator systems, factory equipment). Some locations may require that action (shielding, increased separation, additional grounding) be taken by the distribution designer to mitigate unwanted interference.

4.3.8.8 Equipment Room Parameters

Equipment room designs shall comply with the following list of requirements:

- 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 (see paragraph 4.3.6.2, above). Do not exceed

the distributed floor loading >12 kPa (250 lb./ft²) and a maximum concentrated floor loading >404 kN (1000 lb).

- Location shall be free of water infiltration.
- Equipment Room shall not have water lines, drains, etc., located inside the room or in the overhead ceiling.
- Maintain continuous HVAC, 20 to 25°C (68 to 77°F), 40-55% relative humidity, positive pressure. (See Section 4.3.5 above).
- Vibration levels shall comply to SAES-M-100, (Saudi Aramco Building Code).
- Room size; provide a minimum 0.07 m² space for every 10 m² of usable floor area or Individual Work Area (IWA). The minimum size for a telecommunications equipment room shall not be less 14 m² regardless of the number of IWAs.
- Minimum light levels are 540 lux (50 footcandles) measured 91 cm (3 ft) above the floor level in front of and in the back of equipment racks.
- Restrict personnel access to the telecommunications equipment room by installing as a minimum a combination door lock with a keypad and key.
- Provide interior finishes to reduce dust, enhance lighting, and provide static-free environment.
- Provide emergency lighting.

Refer to the latest issue of TIA/EIA-569-B, (*Commercial Building Standard for Telecommunications Pathways and Spaces*) for additional information.

4.4 Telecommunications Room(s)

4.4.1 General

4.4.1.1 Telecommunications Room(s) (TRs) considered to be floor-serving (as opposed to building serving) facilities that provide a connection point between backbone and horizontal distribution pathways.

4.4.1.2 Buildings larger than 100 m² (1076 ft²) in size (usable space) shall have a Telecommunications Room as a minimum space requirement. In multi-story buildings a minimum of one Telecommunications Room shall be provided for each floor level. There is no maximum number of TRs that may be provided within a building. See paragraph 4.4.2.16 "Size Requirements."

4.4.1.3 Combined with an Entrance Facilities

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. The TR shall provide facilities (space for current and future needs, power, grounding, protection devices, etc.) for housing telecommunications equip. In particular, passive (cable terminations, wall space to mount cable splice closures vertically or horizontally, and not on top of a cable tray or rack) and active (LAN equip) devices are used to interconnect horizontal and backbone systems.

Commentary Note:

Refer to Section 4.2, (Telecommunications Entrance Facility and Termination) for information on entrance facility requirements.

4.4.2 Minimum Design Requirements for Telecommunications Rooms

Telecommunications Rooms shall have as a minimum one hour fire rated walls. The wall height shall extend from the finished floor to the structured roof or ceiling level.

Overhead routing of other utilities shall be avoided to prevent obstruction to Telecommunications Rooms above ceiling access. Refer to NFPA 101 (Life Safety Code), SAES-B-014 (Safety Requirements for Plant and Operations Support Buildings) and SAES-M-100 (Saudi Aramco Building Code) for conditions that require a higher fire rated wall for these types of rooms.

The following table provides the color scheme for Telecommunications Rooms:

Table 6 – Backboard Field Termination Color 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 termination's). **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.

4.4.2.1 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.

Telecommunications Rooms that contain entrance facilities for large entrance cables (600 pair or larger) shall have pulling in iron or support brackets incorporated into them (wall, floor or ceiling) for the purpose of installing cables safely and without damage.

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 to Section 4.9 (Firestopping), SAES-T-628 (Telecommunications -

Underground Cable), SAES-M-100 (Saudi Aramco Building Code) and SAES-B-068 (Electrical Area Classifications).

4.4.2.2 Quantity and Size for Conduits and Sleeves

A minimum of three 100 mm (4 inches) sleeves or conduits shall be provided for the backbone pathways. One (1) 100 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. As a minimum there shall be an additional two (2) spares (100 mm sleeves/conduit) provided in addition to the initial requirement.

A minimum of 2-three inch conduits 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 centimeters (2 inches) maximum at a minimum height of eight (8) feet.

4.4.2.3 Doorways

TR doors shall be at least 91 centimeters (36 inches) wide and 2.0 meters (80 inches) tall. Door sills and center posts shall not be allowed. Hinge doors shall open outward or slide side to side or open inward will be permitted when Loss Prevention codes do not permit outward opening doors.

4.4.2.4 Dust and Static Electricity

Floor tiles shall be installed instead of carpet. Floors, walls, and ceiling shall be treated with paint or coating to minimize dust.

4.4.2.5 Environmental Control

The room (s) shall be provided with heating, ventilation, and air conditioning that will maintain:

- Temperature range of 10°C (50°F) to 35°C (95°F), within + 5°C (+ 9°F), or maintain environment required by the specific equipment to be installed.

- Continuous environmental control (24 hours per day, 365 days per year).

Maintain positive pressure with minimum of one air change per hour in the Telecommunications Room. Air handling equipment must:

- Dissipate the heat generated by active devices.
- Satisfy applicable building codes.

Commentary Note:

This does not apply to Shallow Closets that will only contain passive equipment and terminations during the building life.

4.4.2.6 False Ceilings

False ceilings shall not be permitted in Telecommunications Room(s).

4.4.2.7 Fire Protection

Provide fire protection for each Telecommunications Rooms in accordance to SAES-B-014 (Safety Requirements for Plant and Operations Support Buildings).

Fire sprinkler (wet) systems shall not to be used (unless required by fire or building codes) in the Telecommunications Rooms. Dry type of fire sprinkler systems and fire extinguishers shall be preferred.

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.

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 4.9 for additional information for Firestopping.

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.

4.4.2.8 Flood Prevention

Telecommunications Rooms shall not be located where there is a threat from flooding.

Telecommunications Rooms shall not have water lines, drains, etc., located inside the room or in the overhead ceiling.

4.4.2.9 Floor Loading

Floors of a Telecommunications Room shall be designed to withstand a minimum loading of 2.4 kPa (50 lbf./ft²).

4.4.2.10 Grounding

All telecommunications cable and equipment shall be properly grounded in accordance with Saudi Aramco Engineering Standards and TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

Provide an electric tin plated copper ground bar in Telecommunications Rooms when multiple bonds are to be used. See paragraph 4.6.6.3 below for additional information.

Bond communication grounds to approve ground points such as TMGB, TGB or for telephone switch locations (e.g., Master Ground Bar, Power Entrance Ground, and Cable Entrance Ground Bar). The metallic structural members of a building can be used provided that the conductive pathways are continuous. Connections to the electrical ground system shall be made and comply with SAES-P-111 (Grounding).

Refer to Section 4.7, "Grounding, Bonding, and Electrical Protection" below for additional information.

4.4.2.11 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 TRs shall be based on the usable office space. A TR shall be provided in each corporate

building (office, hospital, dormitory) for every 1,000 m² (10,000 ft²) of usable floor space. Individual TR (s) shall not serve more than 1,000 m² or 100 IWA's.

An additional TR shall be placed when distances between the IWA and the Telecommunications Room exceed the maximum length (90 meters [295 feet]) for horizontal cabling

4.4.2.12 Lighting

Lighting of Telecommunications Rooms and Closets shall be a minimum of 540 lux (50 footcandles) measured 91 cm (3 feet) above the finished floor level. Locate light fixtures a minimum of 2.6 meters (8 feet. 6 inches) above the finished floor.

Use white paint to enhance room lighting. Emergency lighting is required.

4.4.2.13 Location

The following shall be observed when positioning a Telecommunications Room:

- The access door (s) to Telecommunications Rooms (TR) shall be designed/constructed in such a manner that the access door opens to an internal corridor of an environmentally controlled building.

  Exception:

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

- Horizontal cable runs shall not exceed 90 meters (295 feet).

  Commentary Note:

  Some equipment (voice, data, or video communications) wire limits may require shorter distances.

- Ensure common access to TRs in buildings (single or multi-story). A Telecommunications Room or Shallow Closet shall not be placed in a manner which requires access through a locked room (s).

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

4.4.2.14 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 45 centimeters (18 inches) above the floor and placed at 1.8 meter (6 foot) 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. Lighting fixtures shall not be powered from the same electrical distribution panel as the telecommunications equipment in the room.

4.4.2.15 Wall and Rack Space for Terminals

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

a) A minimum clear space of 13-15 cm (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 15-30 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.

b) 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)

c) Vertical management trough shall be placed between equipment racks for easy management and convenient run of patch cords and for extra security.

4.4.2.16 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 following table:

Table 7 – Telecommunications Rooms (TR) Size

If A Serving Area Is	Then It shall served by
Larger than 1000 m² (10,000 ft²)	Multiple TRs are required
Larger than 800 m² and less than or equal to 1000 m² (>8,000 ft² to < 10,000 ft²)	Minimum TR size of 3.0 m X 3.4 m, (10 X 11 ft)
Larger than 500 m² and less than or equal to 800 m² (>5,000 ft² to < 8,000 ft²)	Minimum TR size of 3.0 m X 2.7 m, (10 X 9 ft)
Larger than 325 m² and less than or equal to 500 m² (>3,250 ft² to < 5,000 ft²)	Minimum TR size of 3.0 m X 2.1 m, (10 X 7 ft)
Larger than 100 m² and less than or equal to 325 m² (>1,000 ft² to < 3,250 ft²)	Minimum TR size of 2.1 m X 1.5 m, (7 X 5 ft)
Less than 100 m² (1076 ft²)	Shallow closet that measures at least 0.6 m deep x 2.6 m wide (2 ft deep x 8.5 ft wide) or approved Telecommunications Enclosure or 12U (minimum) enclosed 19" equipment rack

Commentary Notes:

1. *Key systems or data equipment relay racks require a depth of at least 92 cm (36 in).*
2. *All utility cabinets shall be listed and marked in accordance with applicable electrical codes.*
3. *Installation of active equipment requires environmental control and a dedicated power circuit.*

4.4.2.17 Layout Considerations

The design of a Telecommunications Room shall include the following:

Table 8 – 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

4.4.2.18 Clearances

Telecommunications Room (TR) layouts shall allow a minimum of 91 cm (36 inches) of clear work space in front of equipment and termination fields. It is important to note that the clearance is measured from the outermost surface of equipment. A minimum access of 76 cm (30 inches) shall be provided to the rear of equipment for maintenance purposes.

When an equipment rack (s) (e.g., 19 inch/48 cm) is mounted parallel to a TR wall a clearance space of 15 cm (6 inches) shall be maintained between the outer edge of the rack (s) and the TR room wall.

A minimum clearance of 30 cm (12 in) shall be provided between the top rail of cable trays and items above it. Additionally, there shall be a 76 cm (30 inches) of clearance (access space) for maintenance and operational work forces to one side of the cable tray.

4.4.2.19 Termination Space

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

Table 9 – 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).

Commentary 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.*

4.4.2.20 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.

4.5 Video Conference Room

Video conferencing systems are being installed in more and more company buildings in recent years. To provide these video systems, at a point near the conference room where video conferencing (including the associated audio equipment) are to be installed, walk-in rooms of at least 1.5 m x 1.8 m (5 ft x 6 ft) shall be provided. The walk in room shall be equipped with equipment rack and provided with the associated electrical, bonding and grounding and environmental requirements normally provided for Telecommunications Rooms (TR's).

4.6 Building Backbone Systems

4.6.1 Definition of a Backbone System

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, TERs, and Telecommunications Service Entrance (TSER). This system usually consists of one or more copper and or fiber optic cable systems with associated equipment.

4.6.2 Transmission Media

4.6.2.1 Cable Types

The four recognized and most suitable cable types that shall be used for backbone systems are:

- 50/125 µm multimode optical fiber conforms to the OM3 specification (ISO/IEC 11801 Ed.2:2002, OM3, Laser Optimized Fiber)
- 62.5/125 µm multimode optical fiber.

Commentary Note:

62.5/125 and 50/125 MM should never be directly connected (and that the use of "mode-conditioning" fiber optic patch cords is not acceptable).

- Single mode optical fiber.
- 100 ohm balanced twisted-pair (CAT 6).

4.6.2.2 Multi-mode fiber The link between the TR to the TERs shall consist of a minimum of 12 cores of 50/125 MM fiber (ISO/IEC 11801 Ed.2:2002, 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.

4.6.3 Backbone Cable Lengths

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

- From Telecommunications Room to Intermediate Cross-Connect

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.

- From Telecommunications Room to Main Cross-Connect

  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 10 – Backbone Distances

If The Transmission Cable Is	Then the Maximum Length from the Telecommunications Room to the Main Cross-Connect is
62.5/125 and 50/125 µm 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.

4.6.4 Types of Backbone Cable Pathways

4.6.4.1 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 firestopping is maintained at all times.

4.6.4.2 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 firestopping is maintained at all times. See Section 4.9 for additional information.*

4.6.4.3 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 11 – 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.

4.6.4.4 Open Shafts

Occasionally used for tall buildings such as control towers for sea and air ports and if huge amounts of cable are required that are distant from the ER.

4.6.5 Miscellaneous Support Facilities

4.6.5.1 Supporting Strand

Where large heavy backbone cables are used (e.g., 1200 pr. copper and larger), clamp the cable to a support strand suspended between the highest floor of the building and the basement. In addition, cables shall be clamped to vertical cable rack in each Telecommunications Room for support.

Steel strands used for supporting riser cables are available in various sizes designated by the letter "M" which indicates the tensile breaking point in thousands of pounds (e.g., 2.2M, 6M, 10M, etc.). The loads expressed on the steel strands shall not exceed 25% of its rated capacity.

Cable shall be secured with wire ties, straps, wraps that have specific application for securing cable vertically to the support strand. Consult the cable manufacturer for sheath strength characteristics.

4.6.5.2 Other Methods for Securing Vertical Backbone Cable

Listed below are other methods used to properly secure vertical backbone cable:

- Vertical cable ladder racks
- Brackets
- Toggle bolts
- Clamps
- Straps (steel or plastic)
- Masonry hardware

4.6.5.3 Bonding and Grounding

All designs shall provide for the bonding and grounding of all non-network metallic members of backbone cable and associated equipment to a TGB or TMGB. All design drawings shall clearly show all grounding conductors (size and length) and connectors (type and size). A ground busbar shall be provided where there is a requirement to bond or ground more than one connection.

4.6.5.3.1 The ground busbar shall:

- be a predrilled tin plated copper busbar provided with holes for use with standard sized lugs;
- be sized in accordance with the immediate application requirements and with consideration of future growth;
- have minimum dimensions of 6 mm (¼ in) thick x 100 mm (4 in) wide and variable in length;

See Illustration 1 for typical telecommunications main grounding busbar (TMGB).

4.6.5.3.2 The ground busbar shall also be large enough to connect 6 AWG or larger (solid or stranded copper conductors) using a listed double hole connector, from:

- Backbone cable
- Cable splice closure
- Approved power ground on the floor in the TR or IC
- Structural steel
- Telecommunications equipment
- Main equipment room ground bar (TMGB)

Commentary Note:

Proper bonding and grounding is essential element of a building backbone system. Refer to Section 4.7 (Grounding and Bonding and Electrical Protection).

Installation Requirements

a) The TMGB shall be insulated from its support. A minimum of 50 mm (2 in) separation from the wall is recommended to allow access to the rear of the busbar.

b) The TMGB shall be located such that it is accessible to telecommunications personnel. It should be positioned adjacent to the protectors and directly between the protectors and the building ground that is approved for operation. The mounting height of the TMGB should be adjusted to accommodate overhead or underfloor cable routing.

c) The TMGB should be placed to provide for the shortest and straightest routing of the primary protector grounding conductor.

4.6.5.4 Firestopping

Firestopping is a critical element in a backbone system design.

Commentary Note:

Refer to Section 4.9 (Firestopping) below for firestopping requirements.

4.6.6 Cable Markings and Material

4.6.6.1 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 12 – 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	Undercarpet Comm. Wire & Cable	800-51, 800-53

4.6.6.2 Cable Substitutions

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

Table 13 – 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
CMX	MPP, CMP, MPR, CMR, MPG, MP, CMG, CM

4.6.6.3 Fiber Optic Cable Markings

All fiber optic cabling shall be identified and marked with one of the following. The following table (Table 770-50 of the National Electrical Code) summarizes cable markings for optical fiber cables:

Table 14 – 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

4.6.6.4 Fiber Optic Cable Substitutions

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

Table 15 – 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

4.6.7 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.

4.6.8 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-634 (Telecommunications Cable Testing and Acceptance) and TIA/EIA-568A. Test results shall be documented by recording the test data on as-built drawings and documentation package.

4.7 Grounding, Bonding, and Electrical Protection

4.7.1 General

4.7.1.1 Saudi Aramco Outside Plant cable (circuits), and facilities are to be considered "Exposed."

4.7.1.2 Primary protection is required at both ends of the terminated copper communications circuit when it is classified "Exposed."

4.7.1.3 Basic Protection Systems

The systems listed below shall be recognized as performing a unique function within a building. The combination of these systems provides the overall protection for the building and its occupants. Proper design, coordination, and installation of the following systems shall be required:

- Lightning Protection System
- Grounding Electrode System
- Electrical Bonding and Grounding
- Electrical Power Protection
- Communications Bonding and Grounding
- Communications Circuit Protectors
- Site/System Grounding Topologies

4.7.1.4 Lightning Protection System

When a lightning Protections System is present the communications grounds shall be bonded to the lightning protection system grounding if within 3.7 meters (12 ft) of the base of the building and may need additional bonding

depending on:

- Spacing
- Building dimensions
- Construction

Commentary Note:

Refer to NFPA 780 for specific details and information regarding lightning protection systems.

Communications conductors shall not be routed closer than 1.8 meters (6 feet) from any lightning protection system conductors. This separation does not apply when the building structural steel is used as the lightning down conductors. Refer to NEC Section 800-13 for specific information.

4.7.1.5 Communications Bonding and Grounding

All metallic telecommunications conduits, raceways, trunks (pathways) shall be bonded and grounded.

4.7.2 Communications Grounding Practices

A 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 Equipment room.
- Telecommunications Room
- Telecommunications Shallow Closet

Commentary Note:

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

4.7.2.1 Telecommunications Main Grounding Busbar (TMGB)

Telecommunications Main Grounding Busbar (TMGB) shall be connected directly to the closest point of the building electrical service ground or the building electrode system.

The TMGB grounding conductor shall be permanent, electrically continuous, have sufficient capacity to conduct

safely any fault current that is likely to be imposed on it and have sufficiently low impedance to limit the voltage to ground. The conductor shall be placed in a ¾ inch (minimum) trade size PVC conduit. The copper conductor shall comply with the sizing requirements of the National Electric Code (NEC), Table 250-95 "Minimum Size Equipment Ground Conductors for Grounding Raceway and Equipment" when the conductor is required to be sized larger than a no. 6 AWG solid copper conductor (see exception below). Telecommunications grounds shall not connected to power distribution supply panels.

Exception:

The minimum size conductor shall be a no.4 copper conductor when connecting the Telecommunications Main Grounding Busbar (TMGB) to the building ground grid system.

Commentary Note:

A measured reading of less than 3 ohms will be required for sites that contain:

- *Switching equipment*
- *PABX*
- *Radio microwave equipment*
- *Large Antenna*
- *Power stations/plants.*

Refer to the following Saudi Aramco Standards for additional information regarding grounding requirements of less than 25 ohms:

- SAES-T-887, Telecommunications: Electrical Coordination Protection at Power Plants and Radio Stations.
- SAES-T-795, Communications Facility Grounding Systems.

4.7.2.2 Using the Electrical Service Ground

A direct electrical service ground shall be the first choice for grounding communications systems. An accessible means to allow for the connection of the telecommunications grounding system shall be provided for by the building design engineer (Saudi Aramco PMT or Maintenance engineer). This accessible means shall be external to enclosures for connecting inter-systems bonding and grounding conductors

and be provided at the electrical service equipment by one of the following means (2002, NEC 250-94):

- Exposed metallic service raceways.
- Exposed grounding electrode conductor.
- Approved means for the external connection of a copper or other corrosion-resistant bonding or grounding conductor to the service raceway or equipment.
- A direct connection to the building ground grid.

Refer to the NEC, NFPA 70 for conductor and conduit sizes.

Commentary Note:

For equipment ground conductors refer to, NFPA 70 (NEC), Article 250.

Exception:

The electrical service ground conductor is critical to the safety of the electrical power system. Do not remove, modify, or disconnect without the direct participation and approval of the building design engineer or the utilities/maintenance engineer (proponent, POD, etc.) in the case of existing structures.

- Approved external connection on the power service panel.

  Commentary Note:

  The NEC allows direct connection to a provided 6 AWG copper conductor.

4.7.2.3 Installing a Ground Electrode

The installation of a communication electrode is allowed when:

- There is no electrical service ground.

  OR

- Additional grounding is needed (refer to NEC Section 800-40-b). The newly installed electrode shall be bonded to the existing ground electrode system.

The following conditions shall be maintained:

- Any installed grounding electrode must be at least twice the length of the grounding electrode away from other

existing electrodes.

- Electrodes or down conductors that are part of a lightning protection system are not allowed for use as an electrode for the purpose of bonding telecommunications ground systems.
- Gas pipes, and steam pipes, or hot water pipes shall not be considered for use as a ground electrode.
- Cold water (sweet/raw) metallic pipes shall not be considered as a ground electrode due to the extensive use of plastic pipe in these systems.
- WARNING: installed grounding electrode must be at least 6 feet away from another existing electrode.
- The electrode shall be ⅝ inch in diameter, 8 foot long that measures 25 ohms or less.
- The installed grounding electrode shall be driven to a depth of not less than 2.44 m (8 ft).

4.7.2.4 Physical Protection

Physical protection shall be provided for grounding conductors when there is a possibility that it will be subjected to damage from surrounding activities or vehicular traffic. If a metallic conduit or raceway is used to provide mechanical protection for ground conductors, it shall be bonded at both ends to the ground conductor.

A no. 6 AWG size conductor is the minimum sized conductor that shall be run in metallic conduit or race way.

4.7.3 Communications Bonding Practices

4.7.3.1 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.

4.7.3.2 Each telecommunications bonding conductor shall be identified and labeled. The label shall be located on the conductor as close as possible to the termination point.

Labels should be non-metallic and depict the following information:

Exception:

If This Connector or Cable Is Loose or Must Be Removed Contact Saudi Aramco Communication Operations Representative.

Connectors shall be Listed and may consist of the following:

- Mechanical clamps or lugs. (Do not use for Direct Buried Applications)
- Compression type fittings. (Do not use for direct buried applications)
- Exothermic welding

Commentary Notes:

1. *Exothermic welding usually is used in areas subject to corrosion, systems that carry high current, receive little or no maintenance, and within a direct buried ground electrode system.*
2. *Connectors shall be listed for the application and environment in which they are to be placed.*

4.7.3.3 Telecommunications Room(s)

An approved ground source shall be provided to each Telecommunications Room and Shallow Closet. The ground source may be provided by one of the following:

- Telecommunications Main Ground Busbar (TMGB). See illustration 3 for arrangement of Telecommunications Grounding and Bonding.
- Telecommunications Bonding Backbone System (grounding and bonding infrastructure). See Illustration 3 for arrangement of Telecommunications Grounding and Bonding.
- Power service entrance ground (electrode).
- Approved ground source (building ground grid).

The equipment ground of an electrical power panel shall be bonded to the telecommunications ground system of a TR when located in a TR.

4.7.4 Equipment Grounding

4.7.4.1 Equipment Protection

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

Commentary 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.

4.7.4.2 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.

Commentary Note:

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

4.7.4.3 Equipment Manufacturer Warranty

The telecommunications distribution design engineer shall report any conflicts between the Saudi Aramco Engineering Standards and the manufacturer grounding and bonding requirements. All conflicts regarding the grounding and bonding of telecommunications equipment shall be resolved by the Chairman of Communications Standards Committee.

4.7.5 Backbone Cable Protection

4.7.5.1 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 and as shown in Illustrations 0626 and 0627 for the arrangement of Telecommunications Grounding and Bonding Structure for buildings and facilities.

4.7.5.2 Protective measures and devices shall be provided for Saudi Aramco facilities and structures (buildings) as specified by SAES-T-887 (Telecommunications: Electrical Coordination - Protection at Power Plants and Radio Stations) and SAES-T-903 (Telecommunications Outside Plant Electrical Protection and Grounding). Extra measures (as specified by SAES-T-887 and SAES-T-903) shall be reviewed and implemented when facilities and structures (buildings) are located geographically in or near:

- High lightning areas.
- High soil resistivity areas.
- Power substations.
- High voltage overhead lines.

- Heavy industrial facilities.

4.7.5.3 Telecommunications Bonding Backbone

A Telecommunications Bonding Backbone (TBB) is a conductor (6 AWG or larger) that provides direct bonding between different locations in a building, typically between the telecommunications equipment rooms and TRs. Where two or more vertical Telecommunication Bonding Backbone (TBB) conductors are used within a multistory building, the TBBs shall be bonded together with a TBB Interconnecting Bonding Conductor (TBBIBC) at the top floor and at a minimum of every third floor, (see Illustration 0627, paragraph 4.7.9.6).

Note: *Refer to TIA/EIA-607 for additional information.*

4.7.5.4 Coupled Bonding Conductor

A Coupled Bonding Conductor (CBC) is a bonding conductor that provides equalization like a TBB, but also provides a different form of protection through electromagnetic coupling (close proximity) with the telecommunications cable. There are two basic forms of CBC:

- A cable shield.
- Separate copper conductor (6 AWG or larger) tie wrapped at regular intervals to an unshielded cable.

Commentary Note:

In order for the CBC to work properly, it must be connected directly to the protector ground and to the ground at the equipment end.

4.7.5.5 Backbone Cable Shield

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

Commentary Note:

Cable shields do not satisfy requirements for TBB.

4.7.5.6 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:

- 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.)
- 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.

4.7.5.7 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).

4.7.5.8 Shielded Cable Systems

Some indoor cabling systems (most notably those with coax, twinax, or shielded twisted pair wire) 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.

4.7.6 Commercial Building Grounding and Bonding Requirements for Telecommunications

A building grounding and bonding system shall consist of the following:

- A permanent telecommunications grounding and bonding infrastructure independent of telecommunications cable. Design and installed as required by this standard.
- Placing telecommunications bonding connections in accessible locations with approved (listed) components.
- Copper bonding conductors (minimum 6 AWG) are installed through every major telecommunications pathway (backbone pathway) and directly terminated on a grounding busbar (a rigid electro-tin plated copper bar) in each telecommunications equipment location. The bonding bus is also directly bonded to a TGB which is bonded to the building structural steel and other permanent metallic systems (when accessible). The busbar shall be visibly labeled and physically marked.
- A TMGB busbar that is directly bonded to the electrical service grounding electrode system.

4.7.7 Communications Circuit Protectors

4.7.7.1 General

NEC Article 800 part C covers communications circuit protection. This is a primary responsibility of the Distribution designer. These protectors function as: Arresting surges or overvoltages protecting against sustained hazardous currents that may be imposed.

4.7.7.2 Primary Protectors

All exposed telecommunication cable conductors that enter buildings shall be protected with UL-listed protectors terminal. Solid state protectors terminal are preferred; however other types of protectors are acceptable. The protected terminal shall be installed immediately adjacent to the exposed cable point of entry. (Refer to SAES-T-903, Telecommunications Outside Plant Electrical Protection and Grounding).

4.7.8 Specific Site/System Grounding Topologies

4.7.8.1 Isolated Ground

A 6 foot separation from lightening protection system conductors (NEC Section 800-13).

Note: *Refer to NEC Sections 250-74 (Exception 4) and 250-75 for additional information regarding isolated grounding conductors.*

4.7.8.2 Antenna Towers

Towers are especially susceptible to lightning. Antennas with feed cables (coax) entering a building shall be protected. Refer to SAES-T-795 (Communications Facility Grounding Systems), SAES-T-887 (Telecommunications: Electrical Coordination Protection at Power Plants and Radio Stations) and NFPA 780 (Lightning Protection Code) when designing or constructing antennas.

4.7.8.3 Telecommunications Switching Centers

Telecommunications central offices (electronic switching) and computer systems have several unique requirements due to substantial powering and extensive communications circuit applications. For grounding requirements refer to SAES-T-795 (Communications Facility Grounding Systems) when structures (e.g., office and administration buildings, hospitals), house telecommunications central offices (switching) and computer systems.

4.8 Horizontal Cabling systems

4.8.1 General

Horizontal Cabling, systems consist of two basic elements:

4.8.1.1 Horizontal Cable and Connecting Hardware (also called "Horizontal cabling") provide the means for transporting telecommunications signals between the individual work area (IWA) and the TR. These components are the "contents of the horizontal pathways and spaces."

4.8.1.2 Horizontal Pathways and Spaces (also called "horizontal distribution systems") are used to distribute and support horizontal cable and connecting hardware between the IWA

(work area outlet) and the TR. These pathways and spaces are the "container" for the horizontal cabling.

4.8.1.3 Responsibility of the Distribution Designer

The distribution designer shall ensure that the system's design:

- Makes optimum use of the ability of the horizontal cabling system to accommodate change, unconstrained as possible by vendor-dependence.
- When designing horizontal distribution systems, the distribution designer shall observe the requirements of the applicable Saudi Aramco Engineering Standards. All engineered Scopes of Work and Design Drawings shall be reviewed and approved by the telecommunications proponent organization (Communications Engineering and Technical Support/Communications Coordination Division/Project Coordination Group) for capital projects.

4.8.2 Horizontal Cabling and Connection Hardware

4.8.2.1 Design Consideration

- To provide for future needs the horizontal cabling must: Provide flexible cable distribution to work area locations, facilitate ongoing maintenance, and accommodate future changes in equipment and services.
- Horizontal distribution pathways and spaces shall be designed to provide a minimum of one square inch per IWA (10 m^2).
- Horizontal distribution pathways and spaces shall be designed with a minimum of 20% spare capacity for the system expansion, maintenance, and relocation activities.

4.8.2.2 Cable Lengths

- The maximum horizontal distance 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).

  Commentary Note:

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

4.8.2.3 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 undercarpet cable).

Commentary Note:

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

4.8.2.4 Transition Points

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

4.8.2.5 Cable Slack

- Only the minimum amount of slack 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 3m 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.

Commentary Notes:

1. *Include the slack in all length calculations to ensure that the horizontal cable does not exceed 90 m (295 ft).*
2. *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.*

4.8.3 Horizontal Cable

4.8.3.1 Cable Types

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

- Four-pair 100-ohm unshielded category 6 twisted-pair (UTP) cable.
- 2 or more strands of 62.5/125 or 50/125 µm optical fiber cable.

4.8.3.2 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):
  - 4-pair 100 ohm balanced category 6
  - 2 or more strands of, 50/125 µm multimode optical fiber cable
  - 2 or more strands of, 62.5/125 µm multimode optical fiber cable

4.8.3.3 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).

4.8.4 Horizontal Connecting Hardware

Connecting hardware used for horizontal cable connections shall meet the requirements for reliability, safety, and transmission performance specified in:

- TIA/EIA-568A
- ANSI/NFPA-70

4.8.4.1 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 (33 ft).

4.8.4.2 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.

Commentary Notes:

- *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.*
- *An electrical outlet shall be provided for each work area data outlet.*

  Coordinate furniture layouts with the Office Services Department representative and building occupant.

4.8.4.3 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.

4.8.4.4 100-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.

4.8.4.5 50/125 µm & 62.5/125 µm Multimode Fiber Outlets

Horizontal multimode optical fiber cable shall be terminated by a duplex SC-style or ST-style outlet connector (as specified in Sectional Specifications IEC 60874-14, Type SCFOC/2.5 and IEC 60874-10, Type BFOC/2.5 respectively). For new installations and installations with no existing installed fiber, the preferred choice is the SC connector.

For methods and guidelines on the proper installation and connection of horizontal runs of optical fiber cabling, refer to TIA/EIA-568-B.

4.8.4.6 Structured Cabling for Wireless Access Point(s)

For the facilities with Wireless LAN connectivity, Wireless Access Point outlets shall not be installed more than 3.75 meters above finished floor level.

4.8.5 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 90 m (295 ft) of cable allowed between the TR and work area outlet.

4.8.6 Cabling Practices

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

4.8.7 Work Area Cables

Wiring Adapters: Do not use the telecommunications outlets as wiring adapter.

4.8.8 Horizontal Pathways and Spaces

Avoiding Electromagnetic Interference (EMI). 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.

For additional clearance requirements, see TIA/EIA-569-A & NFPA 70.

4.8.9 Types of Horizontal Pathways

4.8.9.1 The main types of horizontal pathways are:

- Underfloor ducts (one-level or two-level), if used, require IT approval
- Cellular floors, if used, require IT approval
- Conduit
- Access (raised) floors
- Ceiling zones and grids
- Undercarpet (restricted to use with flat, undercarpet cables)

Commentary Note:

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

4.8.9.2 Refer to the BICSI Telecommunications Distribution Methods Manual, for the disadvantages, advantages and illustrations of each type of horizontal pathway.

4.8.10 Sizing of Horizontal Pathways

4.8.10.1 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).

Commentary 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".

4.8.10.2 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.

4.8.10.3 Cable Density

Two (2) horizontal cable runs per information outlet; and that for an enclosed IWA (such as an office) it would be normal to have more than one (1) information outlet to allow for different office furniture layouts.

Although only two cable runs are required, the pathway (min. one inch conduit) design shall allow for at least four cable runs per individual work area, to facilitate additions and changes as user needs evolve.

4.8.10.4 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 16 – 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.)

4.8.10.5 Conduit Capacity

Table 17 provides cable capacity for conduits having cross-sectional areas ranging from 2 cm^2 (0.3 in^2) to 82 cm^2 (12.7 in^2), (refer to TIA/EIA-569-A).

Table 17 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 17 – Conduit Capacity for Horizontal Cabling

Cable Outside Diameter mm (in.)

Diameter Internal 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.

4.8.10.6 The maximum conduit fills allowed by NFPA 70 are shown in Table 18. Other limitations apply (refer to NFPA 70).

Table 18 – Maximum Conduit Fills for Horizontal Cabling

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

4.8.10.7 Determining Conduit Size

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

Table 19 – 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 IWAs 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.)

4.8.10.8 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.

4.8.10.9 Determining Duct Size

The minimum size feeder and distribution duct or tray (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.

4.8.11 Underfloor Duct System

4.8.11.1 Underfloor duct systems are a network of metal raceways embedded in concrete which facilitates the distribution of horizontal cables (i.e., between TRs 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 for additional information regarding Under Floor Duct Systems.

4.8.11.2 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.

4.8.11.3 Junction Boxes

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

4.8.12 Design Requirements for Underfloor Ducts

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

4.8.12.1 Feeder Duct

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

Commentary 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.*

4.8.12.2 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).

4.8.12.3 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.

4.8.12.4 Distribution Duct Sizes

Standard distribution duct size range 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).

4.8.12.5 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).

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

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.

Commentary Note:

For more information on the termination of horizontal pathways in the Telecommunications Room, see Section 4.4, "Telecommunications Rooms."

4.8.13.1 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.

4.8.13.2 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.

4.8.14 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.

4.8.15 Cellular and Underfloor Floor Systems

4.8.15.1 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).

4.8.15.2 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.

4.8.16 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 IWAs or a high rate of moves, adds and changes (MACs).

4.8.16.1 Suitable Conduits

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

4.8.16.2 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 paragraph 4.8.20.1, (Overhead Ceiling Raceway Method) below for additional information on the use of flexible conduit.

4.8.16.3 Acceptable Conduit Runs

Conduit runs shall be designed to:

- Run in the most direct route possible (usually parallel to building lines), with no more than two 90° bends between pull points or pull boxes.
- Contain no 90° condulets (also known as LB).
- Contain no continuous sections longer than 30 m (100 ft).

A length of 45 m (150 ft) or less (including the sections through pull boxes).

Commentary Note:

For runs that total more than 30 m (100 ft) in length, insert pull points or pull boxes so that no segment between points/boxes exceeds the 30 m (100 ft) limit.

4.8.16.4 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.

4.8.16.5 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:

$$\text{Cross Sectional Area} = (0.785) \times (\text{Diameter})^2 \qquad (1)$$

4.8.16.6 Bend Radii for Conduits

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

4.8.16.7 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 20 – 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

4.8.16.8 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.)

4.8.16.9 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).

4.8.16.10 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.

4.8.17 Access (Raised) Floors

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

4.8.18 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

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.

4.8.18.1 Ceiling Zones Method

The usable floor area in the "Ceiling Zones" shall be divided into zones of 35 m^2 to 82 m^2 (365 ft^2 to 900 ft^2) 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 17 in paragraph 4.8.10.5. 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.

4.8.18.2 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.

Commentary Note:

The outlet box shall not serve as a pull point.

4.8.18.3 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.

4.8.18.4 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.

4.8.18.5 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

  Commentary 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, and*
  2. *Headroom depth space of at least 30 cm (inches) above the top surface of cable tray side rails. This headroom space or area shall cover the space above the cable tray as well as the area above the 76 cm (30 inches) depth access space*
  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.*

  AND/OR

- Open-top Cable Supports (J-supports)

  Commentary 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, 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.

4.8.18.6 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 m² to 60 m² (350 ft² to 600 ft²). For larger zones ranging from 60 m² to 90 m² (600 ft² to 900 ft²), use 6.3-cm (2½-in.) conduit.

Commentary 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.

4.8.19 Cable Tray Design for Ceiling Distribution Systems

4.8.19.1 Cable Tray Systems

Cable tray systems are commonly used as distribution systems for cabling within a building. They are often preferable to rigid conduit and raceway systems because of their greater accessibility and ability to accommodate change. Cable tray systems:

- Are rigid, prefabricated support structures that support telecommunications cables and cabling.

- Shall be installed to comply with:
  - NFPA 70, NEC Article 392 (2002 Edition) requirements
  - SAES-M-100, Saudi Aramco Building Code
  - TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.

Cable tray designs shall not use cable trays systems to distribute telecommunications and power cables together. Cable trays shall not be installed in ceiling areas (lock tiles, drywall or plaster) that are inaccessible. The only exception is when a ceiling access opening is provided and overhead (above ceiling) walkway is provided within 300 mm of the cable tray.

Cable trays should be installed in corridor areas. Office areas should be avoided.

Commentary Note:

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

4.8.19.2 Cable Tray Fittings

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

- Elbows
- Reducers
- Crossovers
- Tees

4.8.19.3 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: *Never use cable trays as walkways or ladders.*

4.8.19.4 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.

Trays shall be marked and identified as specified in Section 4.10.

4.8.20 Overhead Raceways for Ceiling Distribution Systems

4.8.20.1 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).

Commentary 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 telepoles.

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).*

4.8.20.2 Designing Ceiling Raceway System

1. Raceways shall be placed parallel to either the:

   - Wall of the TR

     OR

   - Longest outside building wall.

   Commentary 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 90 m (295 ft) long.

2. 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.

   Commentary 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.

4.8.21 Termination and Location of Horizontal Cable and Pathways

The termination of all horizontal cabling and pathways systems into Equipment Rooms and TRs 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).

4.8.22 Outlet Boxes

4.8.22.1 Wall-Mounted Outlets

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).

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 interconnect them with conduit.

4.8.22.2 Cover Plates

Cover plates for wall-mounted outlets shall:

- Have two connector openings.
- Be installed on all outlets 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.

4.8.22.3 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.

4.8.22.4 Mounting Wall Outlets

Wall outlets shall be securely mounted at least 38 cm (15 in.) above the finished floor or, a minimum of 150 mm above desk tops, where it is necessary to locate the outlet behind a desk location. Wall outlets shall always be placed where they

are accessible and allow for the equipment service cord to readily connected.

Commentary Note:

To provide uniform appearance and accessibility in the work area, it is desirable to mount telecommunications outlet boxes at the same height as the outlet boxes that provide electrical power.

4.9 Firestopping

4.9.1 All Firestop Materials shall be listed/qualified for the specific application that they are to be used. Refer to the latest issue of the BICSI TDMM for information regarding the design and installation for firestopping. For additional information regarding firestop methods, materials and application contact the Saudi Aramco Chief Fire Prevention Engineer.

4.9.2 Silicone Foam fire seal products shall not be used for permanent (in excess of five years) fire seals. However, may be used as a temporary seal (less than a 5 year period) during a construction period or for seals that are frequently (annually) changed out. Listed fire seal packets, which can be easily installed and removed for cable installations, are preferred.

Commentary Note:

Next Generation Firestop Technology

New Wiremold FlameStopper Thru-Wall Fitting provides installers with a UL Classified, ready-to-use option for transitioning cables through firewalls to ensure that the integrity of the fire rating is maintained. The fittings have been tested by Underwriters Laboratories, Inc. to ASTM E814 UL 1479, Fire Tests of through Penetration Firestops. The FlameStopper Thru-Wall Fitting offers a passive fire and life safety system with ratings up to 4 hours (with or without cables installed) to complement existing sprinkler systems. A must for high traffic penetrations, FlameStopper Thru-wall Fittings provide firestopping compliance whether they are empty or fully loaded. Cables may be added easily without the need to move or add firestopping materials.

The FlameStopper Thru-Wall Fitting consists of two box assemblies with adjustable steel doors that attach to EMT conduit by mounting brackets. Intumescent firestopping material is factory installed and no other firestopping material is required.

4.10 Administration

The Administration of Saudi Aramco telecommunications infrastructure shall be done as specified by TIA/EIA-606 (The Administration Standard for the

Telecommunications Infrastructure of Commercial Buildings). 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 Installation

5.1 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.

5.2 Structured Cabling System (SCS) installation work should be done by qualified and certified work team consisting of at least a BICSI Installer Technician; BICSI Installer Level II; and a BICSI Installer Level I and other staff as required.

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

6 Testing and Inspection

6.1 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. The outside plant and feeder/backbone cable(s) shall be tested to the performance requirements of SAES-T-634 (Telecommunications Cable Testing and Acceptance).

Commentary Notes:

1. *All measuring and test equipments 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.

6.2 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.

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

6.4 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).

6.5 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).

7 Index of Tables

8 List of Illustrations

Revision Summary

10 February 2013	Revised the "Next Planned Update." Reaffirmed the content of the document, and reissued with no other changes.
9 September 2013	Minor revision to clarify ambiguity of some of the requirements.

Illustration 1 – Typical Telecommunications Main Grounding Busbar (TMGB)

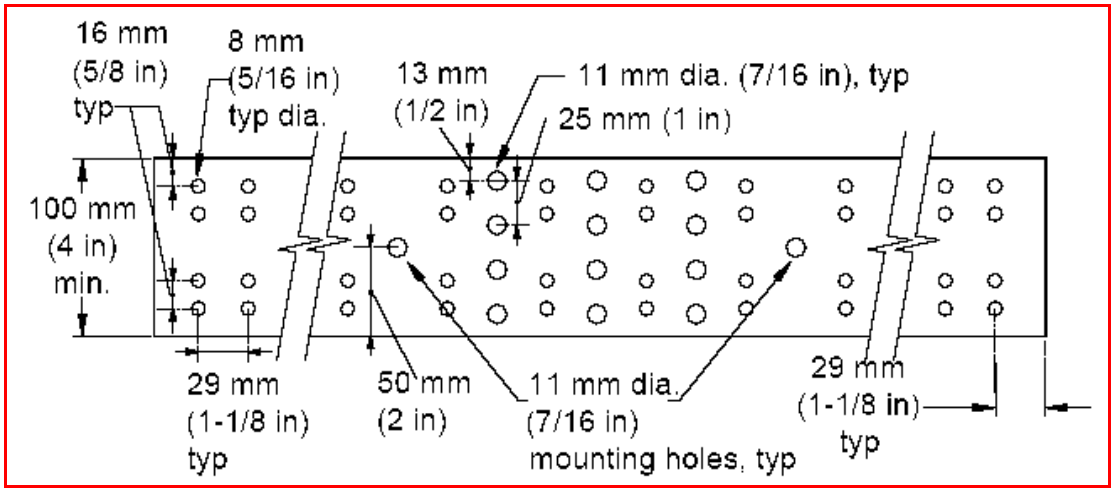

Illustration 2 – Color Coding for Cable Termination

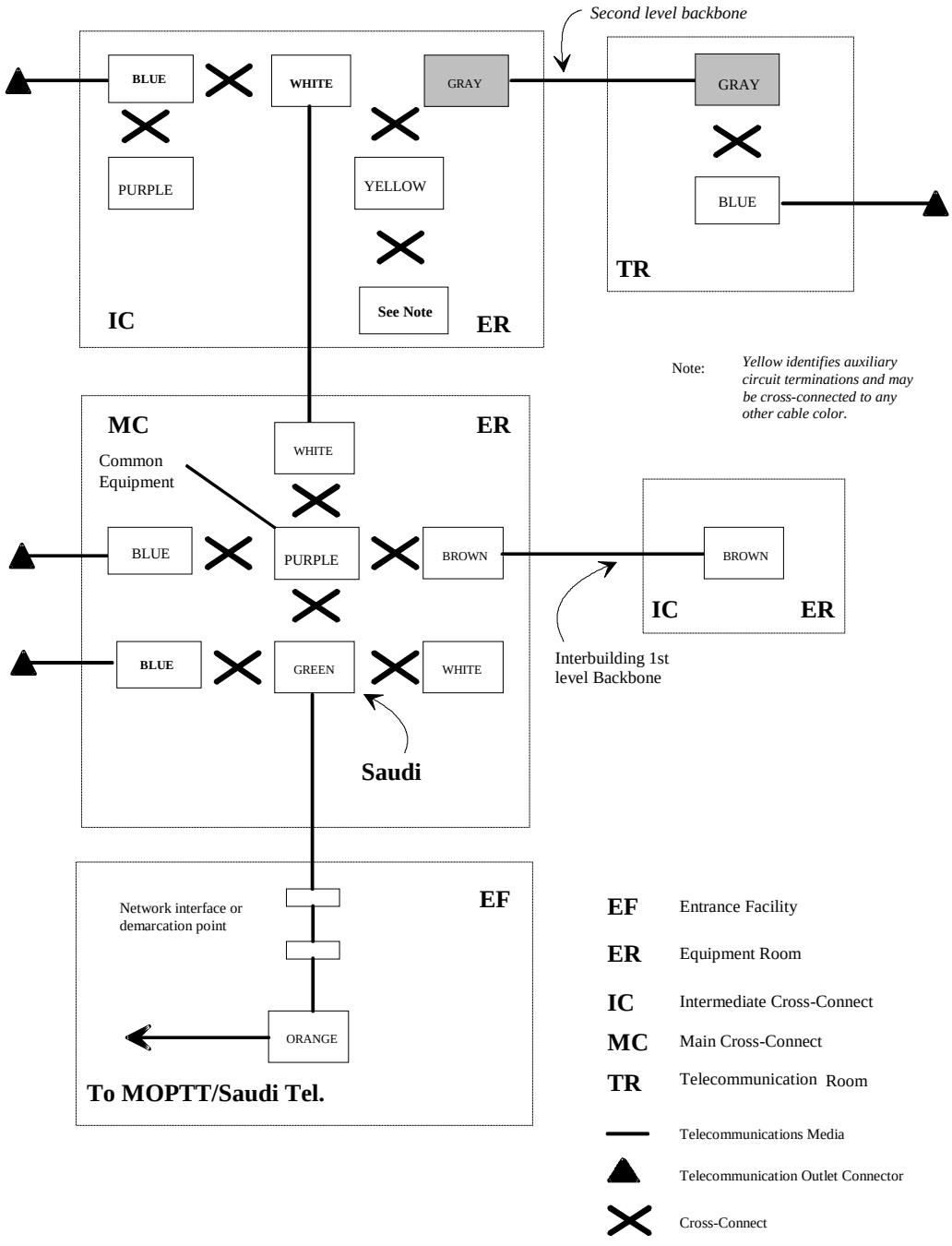

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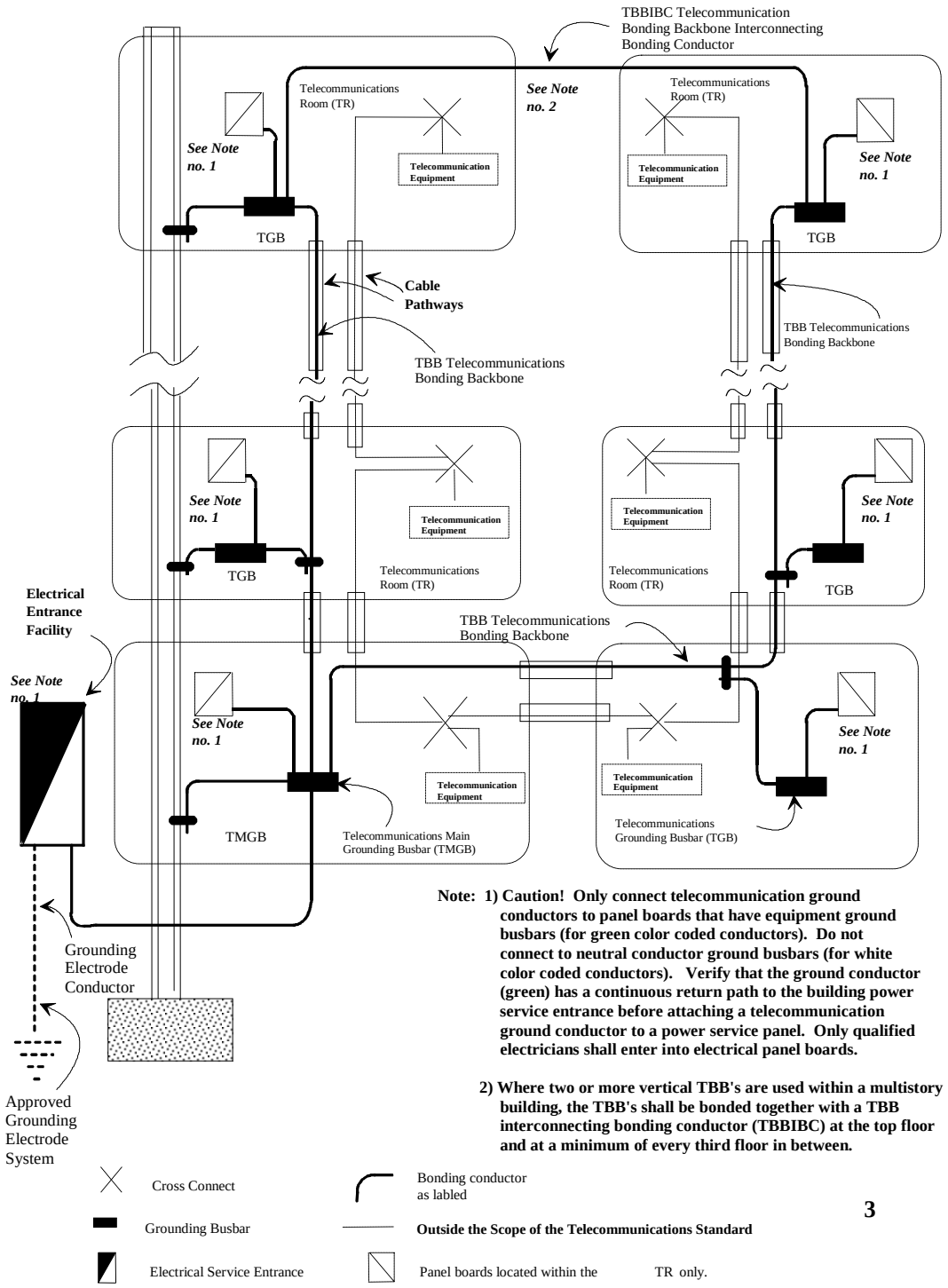
Illustration 3 –Typical Arrangement of Telecommunications Backbone Bonding (TBB) Structure for Large Buildings and Facilities



Note: 1) Caution! Only connect telecommunication ground conductors to panel boards that have equipment ground busbars (for green color coded conductors). Do not connect to neutral conductor ground busbars (for white color coded conductors). Verify that the ground conductor (green) has a continuous return path to the building power service entrance before attaching a telecommunication ground conductor to a power service panel. Only qualified electricians shall enter into electrical panel boards.

2) Where two or more vertical TBB's are used within a multistory building, the TBB's shall be bonded together with a TBB interconnecting bonding conductor (TBBIBC) at the top floor and at a minimum of every third floor in between.

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