ANSI/NECA/BICSI 568-2001

Standard for

Installing Commercial Building Telecommunications Cabling

Published by

BICSI®

A Telecommunications Association

Jointly developed with

National Electrical

Contractors Association

An American National Standard

Table of Contents

FOREWORD

In 1998, a large number of companies representing the telecommunications and electrical industry expressed concern over the lack of a standard for installation of telecommunications premises cabling systems. The National Electrical Contractors Association™ (NECA™) asked BICSI®, A Telecommunications Association, to jointly undertake the task of developing the required standard. BICSI® accepted the task and the project was assigned to BICSI/NECA Joint Technical Committee 1 for the Development of Telecommunications Cabling Installation Guidelines.

BICSI and NECA standards documents are developed within the Technical Committees of BICSI and NECA. Members of these committees serve voluntarily and without compensation. The companies they represent are not necessarily members of BICSI or NECA. The standards developed within these committees represent a consensus of the broad expertise on the subject. This expertise comes from within BICSI and NECA as well as from those outside that have an expressed interest.

The viewpoint expressed at the time this standard was approved was from the contributors' experience and the state of the art at that time. Users are encouraged to check to see that they have the latest revision of the standard.

BICSI/NECA/JTC1 reviews its standards, at the minimum, every 5 years. At that time standards are reaffirmed, rescinded or revised according to the submitted updates. Updates to be included in the next revision should be sent to the committee chair or to BICSI/NECA/JTC1.

This standard has been prepared by BICSI/NECA/JTC1 under the joint jurisdiction of BICSI and NECA and approved by consensus ballot.

1. Scope

A structured cabling system is a complete collective configuration of cabling and associated hardware on a premises which, when installed, provides a comprehensive telecommunications infrastructure. This infrastructure is intended to support a wide range of telecommunications services such as telephone and computer networks. Figure 1 illustrates an example of components that comprise a structured cabling system.

This Standard describes procedures for installing cabling that carries telecommunications signals (e.g., voice, local area network). It specifies minimum requirements for telecommunications cabling installations. This standard is intended to be used in describing a "neat and workmanlike manner" as required by the *National Electrical Code (NEC)*, Sections 110-12 and 800-6.

Installers should always follow the *NEC*, applicable state and local codes, and manufacturers' instructions when installing electrical and telecommunications products and systems. Information within this standard is intended to comply with the following:

- ANSI/NFPA 70, 2002; *National Electrical Code®*
- ANSI/TIA/EIA 568-B Series-2001, *Commercial Building Telecommunications Cabling Standard*
- ANSI/TIA/EIA 569-A-1998, *Commercial Building Standard for Telecommunications Pathways and Spaces*
- ANSI/TIA/EIA 606-1993, *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
- ANSI/TIA/EIA 607-1994, *Commercial Building Grounding and Bonding Requirements for Telecommunications*
- ANSI/NFPA 101, 2000, *Life Safety Code*
- ANSI/NESC, 1997, *National Electrical Safety Code*

This Standard describes the installation of twisted pair copper cabling and optical fiber cabling that meets ANSI/TIA/EIA-568-B performance.

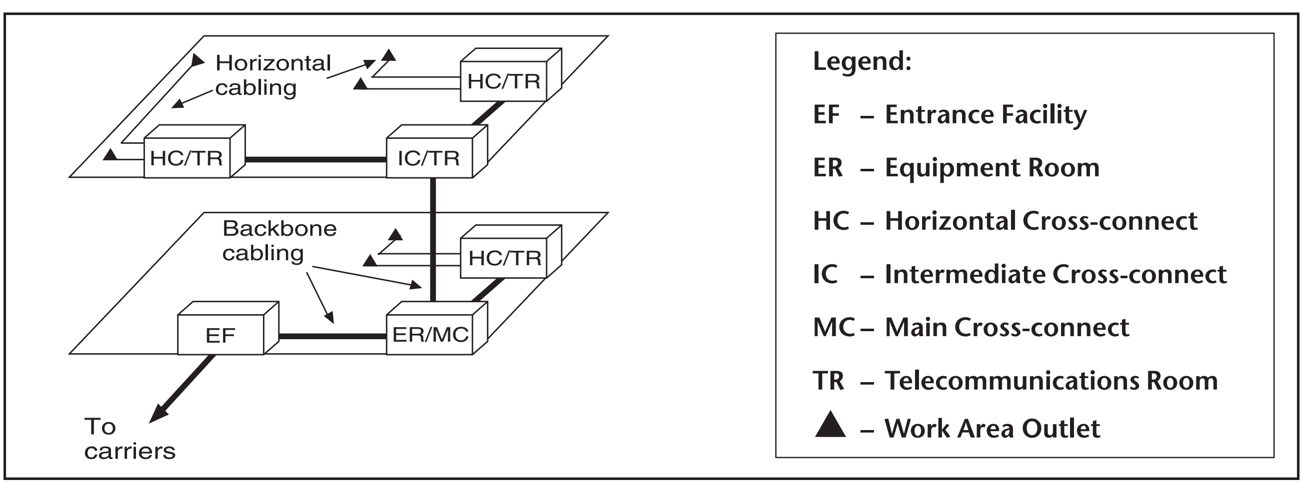

Figure 1. Example of structured cabling system

2. Definitions, Acronyms, Abbreviations, and Units of Measure

2.1 Definitions

For the purposes of this Standard, the following definitions apply.

administration: The method for labeling, documentation, and usage needed to implement moves, additions, and changes of the telecommunications infrastructure.

all-threaded-rod: A straight section of round rod stock that has threads installed over its entire length. Also known as a threaded rod.

American wire gauge: A system used to specify wire size. The greater the wire diameter, the smaller the value (e.g., 24 AWG [0.51 mm (0.020 in)]).

anchor: 1. In a premises environment, a device inserted into a prepared hole in which a screw or bolt has been inserted. 2. In an outside plant environment, a device made up of a single plate or series of flat plates, and combined with a rod having a connecting eye. When the plates are direct-buried and the rod is exposed, the device becomes a secure point to connect to for stability.

architectural assemblies: Walls, partitions, or other barriers that are not load bearing.

architectural structures: Walls, floors, floor/ceilings, and roof/ceilings that are load bearing.

as-built: Documentation that indicates cable routing, connections, systems, and blueprint attributes upon job completion that reflects changes from the planned to the finished state.

attenuation: The decrease in magnitude of transmission signal strength between points, expressed as the ratio of output to input. Measured in decibels (dB), usually at a specific frequency for copper or wavelength for optical fiber, the signal strength may be power or voltage.

authority having jurisdiction: The building official, electrical inspector, fire marshal, or other individuals or entities responsible for interpretation and enforcement of local building and electrical codes.

backboard: A panel (e.g., wood or metal) used for mounting connecting hardware and equipment.

backbone: A facility (e.g., pathway, cable, or conductors) between telecommunications rooms, or floor distribution terminals, the entrance facilities, and the equipment rooms within or between buildings.

backbone cable: *See backbone and backbone cabling.*

backbone cabling: Cable and connecting hardware that provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities. *See backbone.*

backbone pathway: The portion of the pathway system that permits the placing of backbone cables between the entrance location and all cross-connect points within a building and between buildings.

bandwidth: A range of frequencies, usually the difference between the upper and lower limits of the range, expressed in Hz. It is used to denote the potential capacity of the medium, device, or system. In copper and optical fiber cabling, the bandwidth decreases with increasing length.

barrier: A partition installed in a raceway or cable tray that provides complete separation of the adjacent compartment.

beam clamp: Device attached to a beam or other building structure above the ceiling to hold cable supports or equipment.

bend radius: Maximum radius that a cable can be bent to avoid physical or electrical damage or cause adverse transmission performance.

binder group: A group of wire pairs found in a large cable. Groups can be distinguished from one another through the use of colored threads. Standard color-coding provides for 25 pairs per binder group.

blueprint: A reproduction of an architectural plan and/or technical drawing that provides details of a construction project or an existing structure. These drawings are printed on special paper that allows graphics and text to appear as blue on a white background.

bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity, the capacity to safely conduct any current likely to be imposed, and the ability to limit differences in potentials between the joined parts.

bonding conductor: A conductor used specifically for the purpose of bonding.

braid: Cable shield that consists of interwoven metallic strands to surround insulated conductors.

bridle ring: A ring that is circular in shape but is open rather than closed. It has a pointed shaft at its apex that is threaded for installation into wood or pre-threaded devices.

bullwheel: Large wheel used to maintain bend radius when feeding large diameter cables into a pathway.

bundle: 1. Many individual optical fibers contained within a single jacket or buffer tube. Also, a group of buffered optical fibers distinguished in some fashion from another group in the same cable core. 2. Also used to indicate time and common handling of multiple cables routed together.

cabinet: An enclosed container with four rails used for mounting a wide variety of miscellaneous equipment inside them (e.g., fans, power strips, connection devices, terminations, apparatus, wiring, equipment, etc.). They are available in a wide variety of sizes for either wall-mounting or self-supporting.

cable: An assembly of one or more insulated conductors or optical fibers within an enveloping sheath, constructed to permit use of the conductors or optical fibers singly or in groups. See aerial cable; direct-buried cable; hard-sheath cable; underground cable.

cable rack: The vertical or horizontal open support structure (usually made of aluminum or steel) that is attached to a ceiling or wall.

cable run: A length of installed media in between connection points, which may include permanent splices.

cable sheath: A covering over the optical fiber or conductor assembly that may include one or more metallic members, strength members, or jackets.

cable support system: A combination of conduits, cable trays, support hooks, tie wraps, and any other hardware pieces used in a cabling installation to support cables. Cable support systems keep excess stress off the cables and may provide some mechanical protection to the cables being supported.

cable termination: 1. Item used for attaching the pairs of a cable to allow for connecting the cable to other cables or devices. Examples of cable termination hardware are: patch panels, connecting blocks, patch blocks 66M-, 110- or BIX-type, and modular jacks. 2. The connection of the wire or optical fiber to a device, such as equipment, panels, or a wall outlet.

cable tray: A support mechanism used to route and support telecommunications cable or power cable. Typically equipped with sides that allow cables to be placed within the sides over its entire length.

cable tree: Vertical rack with multiple arms for holding small reels of cable.

cabling: A combination of all copper and optical fiber telecommunications cables, equipment/patch cords, and connecting hardware.

cabling system: A specific system of telecommunications cables, equipment/patch cords, connecting hardware, and other components that is supplied as a single entity.

channel: 1. The end-to-end transmission between two points to which application-specific equipment is connected including the patch cords at the device location and at the telecommunications room. 2. ANSI/TIA/EIA-568-B.1 defines a channel as up to 90 m (295 ft) of horizontal cable with connectors (work area and telecommunications room), plus up to 10 m (33 ft) of patch cords and equipment cords.

channel stock: A metallic u-shaped bar with spaced holes often hung in a trapeze configuration for support of pathway systems, such as conduits and trays.

circuit: The electrical or optical path used for communications between two devices.

code: A systematic collection of regulations and rules intended to ensure safety during installation and use of materials, components, fixtures, systems, premises, and related subjects. Codes are typically invoked and enforced through government regulation.

commercial building: A building, or portion thereof, that is intended for office use.

composite: Made up of disparate or separate parts (e.g., copper and optical fiber cables).

conduit: A rigid or flexible metallic or non-metallic raceway of circular cross-section through which cables can be pulled.

conduit elbow: A bend in a section of conduit, usually at a specified radius and degree of turn.

conduit stub-out: A short section of conduit that is installed from a receptacle box, usually in a wall, through a suspended ceiling space a short distance to an adjacent hallway.

conduit stub-up: A short section of conduit that is installed from a receptacle box, usually in a wall, to a suspended ceiling space immediately above the receptacle box.

cone: Safety marker that is used to designate a secure off-limits area for non-workers.

connecting hardware: A device, or combination of devices, used to connect two cables or cable elements.

connector: A mechanical device used to provide a means for aligning, attaching, and achieving continuity between conductors or optical fibers.

consolidation point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

contractor: A person or company contracted to perform a specific task.

cord (telecommunications): A cable using stranded conductors for flexibility, as in distribution cords or line cords.

core: The central, light-carrying part of an optical fiber through which light pulses are transmitted.

crimp: The act of clamping connectors to a cable.

cross-connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

cross-connection: A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.

crossed pairs: Error condition in twisted-pair wiring where pairs are reversed.

crosstalk: The unwanted reception of electromagnetic signals on a communications circuit from another circuit.

current: Flow of electrons in a conductor measured in amperes.

data: Electronically encoded information.

decibel: A logarithmic unit used for expressing the loss or gain of signal strength. One dB is the amount by which the pressure of a pure sine wave of sound must be varied in order for the change to be detected by the average human ear.

dressing: Placing cables into a neat and symmetrical pattern for proper alignment and positioning for termination.

D-ring: Wire management ring made of metal or plastic, and shaped like the letter D for routing and supporting distribution cables and/or cross-connections on a backboard.

drywall: An interior wall construction consisting of gypsum or plasterboard.

duct: 1. A single enclosed pathway for conductors or cables, usually placed in soil or concrete. 2. An enclosure in which air is moved. Generally part of the heating, ventilation, and air conditioning system of a building.

elastomeric firestop: A flexible firestopping material resembling rubber.

entrance facility (telecommunications): An entrance to a building for both public and private network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

entrance point (telecommunications): The point of emergence for telecommunications cabling through an exterior wall, a floor, or from a conduit.

entrance room or space (telecommunications): A space in which the joining of inter or intrabuilding telecommunications backbone facilities takes place.

equal level far-end crosstalk: A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end, and normalized to the received signal level.

equipment room (telecommunications): A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of its nature or complexity.

exposed: When a circuit is in such a position that in case of failure of supports or insulation, contact with another conductor may result.

far-end crosstalk: Crosstalk measured and expressed in dB at the opposite end from which the source signal is transmitted. The unwanted reception or coupling of signals by one wire pair from another wire pair at the opposite end of a link. Contrast with near-end crosstalk.

fastener: A screw, bolt, or nail-like device that is used to secure an item to a wall, floor, or ceiling with an anchor.

fiber: Thin filament of glass or plastic that conducts a light signal. See optical fiber and plastic optical fiber.

fire retardant: Any substance added to delay the start of ignition or fire or slow the spread of the flame of any material.

firestop: A material, device, or assembly of parts in an architectural barrier to prevent vertical or horizontal passage of flame, smoke, water, or gases through the rated barrier.

firestopping: The process of installing specialty materials into penetrations of fire-rated barriers to re-establish the integrity of the barrier. *See cementious firestop and elastomeric firestop.*

firestop system: A specific listed assembly consisting of the material(s) (firestop penetration seals) that fill the opening in the wall or floor assembly, and around and between any items that penetrate the wall or floor (e.g., cables, cable trays, conduit, ducts, pipes), and any termination devices (e.g., electrical outlet boxes), along with their means of support.

firewall: 1. A wall that helps prevent fire spreading from one fire zone or area to another, and that runs from structural floor to structural ceiling. 2. One or more security mechanisms designed for access control and authentication to prevent, detect, suppress, and/or contain unauthorized access to a network. Firewalls are designed to keep unwanted and unauthorized traffic from a protected network.

fire zone: A contained area completely enclosed by fire-resistant rated walls, floors, and ceilings.

floor slab: 1. The upper part of a reinforced concrete floor that sits on beams. 2. A concrete mat poured on subgrade serving as a floor rather than as a structural member.

foiled twisted-pair cable: *See screened twisted-pair cable.*

foldback splicing: Process of folding back conductors in a splice for future maintenance or rearrangements.

frequency: 1. The measure of the number of cycles (waves) per second, expressed in Hertz (Hz). 2. The number of identical cycles per second of a periodic wave.

fusion splice: A permanent joint accomplished by applying localized heat sufficient to fuse or melt the ends of two optical fibers together, forming a continuous single fiber.

ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

ground electrode: A conductor, usually a rod, pipe, or plate (or group of such conductors), in direct contact with the earth providing a connection point to the earth.

grounded: Connected to earth or to some conducting body that serves in place of the earth.

ground wire: *See grounding conductor.*

grounding conductor: A conductor used to connect electrical equipment to the grounding electrode to the building's main grounding busbar.

grounding system: A system of hardware and wiring that provides an electrical path from a specified location to an earth ground point.

hanger: A device that is used to hold something in position.

hertz: A unit of frequency equal to one cycle per second.

horizontal cable: Cable that runs from the telecommunications room to a device location. It may be installed in either a horizontal or vertical plane.

horizontal cabling: The cabling between and including the work area telecommunications outlet/connector and the horizontal cross-connect (floor distributor) in the telecommunications room.

horizontal cross-connect: A group of connectors, such as patch panel or punch-down block, that allows equipment and backbone cabling to be cross-connected with patch cords or jumpers. Floor distributor is the international term for horizontal cross-connect.

infrastructure (telecommunications): 1. A collection of those telecommunications components, excluding equipment, that together provide the basic support for the distribution of all information within a building or campus. 2. Substructure of system used to support the cable plant being installed.

in-line splice: A splice in which cable enters one endcap and, after splicing the cable, exits the other endcap of the closure.

innerduct: A non-metallic pathway placed within a larger pathway.

insulation: The dielectric material that physically separates wires and prevents conduction between them.

insulation displacement connector: A type of wire terminating connection in which the insulation jacket is cut by the connector where the wire is inserted.

interconnect: A location where interconnections are made.

interconnection: A connection scheme that provides for the connection of a cable to another cable or to an equipment cable.

intermediate cross-connect: The connection point between a backbone cable that extends from the main cross-connect (campus distributor) (first-level backbone) and the backbone cable from the horizontal cross-connect (floor distributor) (second-level backbone). Building distributor is the international term for intermediate cross-connect.

jacket: The outer layer of a cable. *See cable sheath*.

J-hook: A supporting device for horizontal cables that is shaped like a "J". It is attached to some building structures. Horizontal cables are laid in the opening formed by the "J" to provide support for the cables.

jumper: 1. An assembly of twisted pairs without connectors, used to join telecommunications circuits/links at the cross-connect. 2. An optical fiber cable with connectors installed on both ends. See cable assembly.

ladder rack: A device similar to a cable tray but more closely resembles a single section of a ladder. It is constructed of metal with two sides affixed to horizontal cross members.

link: A transmission path between two points, not including terminal equipment, work area cables, patch cables, and equipment cables. Can be up to 90 m (295 ft) in length for horizontal cabling.

local area network: A geographically limited data communications system for a specific user group consisting of a group of interconnected computers sharing applications, data, and peripheral devices such as printers and CD-ROM drives intended for the local transport of data, video, and voice.

loss: Attenuation of the optical signal, usually measured in dB.

main cross-connect: The cross-connect normally located in the (main) equipment room for cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables. Campus distributor is the international term for main cross-connect.

megahertz: A unit of frequency equal to one million cycles per second (hertz).

membrane penetration: An opening through only one surface or side of a barrier.

modular furniture: Groups of low-wall partitions, desks, and furniture assembled in the field in open spaces within an office.

modular patch panel: A facility enabling the terminating of cable elements on insulation displacement connector modules and their connections by means of a patch cord.

multimode: Transmits or emits more than one propagating mode.

multimode optical fiber: A graded-index or step-index optical fiber that supports the propagation of more than one bound mode.

mushroom: A plastic guide in the shape of a mushroom, used for routing jumpers.

***National Electrical Code® (NEC®)*:** A safety code written and administered by the National Fire Protection Association.

National Fire Protection Association (NFPA®): Association that writes and administers the *National Electrical Code®*.

near-end crosstalk: The unwanted signal coupling between pairs. It is measured at the end of a cable nearest the point of transmission. Contrast with far-end crosstalk.

network: A group of three or more nodes that can communicate with each other, either directly through common wiring or indirectly through repeaters to separated wiring. *See data network.*

ohm: The standard unit of electrical resistance that measures the opposition to the flow of direct current, called resistance, or opposition to the flow of alternating current, called impedance. One volt will cause one ampere of current to flow through one ohm of resistance. The symbol is Ω.

optical fiber: Transmission medium using glass or plastic to transmit pulse light signals. Its bandwidth is higher than copper and not subject to electromagnetic interference. The optical fiber consists of a central core (glass or plastic) and an outer cladding. *See fiber and plastic optical fiber*.

optical fiber cable: Cable made up of one or more strands of optical fiber, strength members, and an outer jacket.

outlet box (telecommunications): A metallic or non-metallic box mounted within a wall, floor, or ceiling and used to hold telecommunications outlets/connectors or transition devices.

outlet/connector (telecommunications): Mechanical cable termination device for horizontal cable in the work area.

pair: 1. Two insulated wires twisted around each other. 2. One side circuit (two diametrically facing conductors) in a star quad.

pair count: Indicates how many pair of wires are in a cable or the pair identification serving a location.

patch cord: A length of cable with connectors on one or both ends used to join telecommunications circuits/links at the cross-connect.

patch panel: *See modular patch panel.*

pathway: 1. A sequence of connections that provides the connectivity between devices on a network or between networks on an internetwork. 2. The vertical and horizontal route of the telecommunications cable.

plenum: A designated area used for transport of environmental air as part of the air distribution system. Because it is part of the air distribution system, cables installed in this space require a higher fire rating.

plenum rated: Meeting flammability and smoke requirements for the purpose of fire, life, and safety as described by the *National Electrical Code® (NEC®)*.

power sum equal level far-end crosstalk loss: A computation of the unwanted signal coupling from multiple transmitters at the near end into a pair measured at the far end, and normalized to the received signal level.

power sum near-end crosstalk: Power sum assumes all pairs in a cable contribute in crosstalk, using a formula that totals crosstalk power.

power sum near-end crosstalk loss: A computation of the unwanted signal coupling from multiple transmitters at the near end into a pair measured at the near end.

premises: A generic term that includes a building or set of buildings on common property that are occupied by a single tenant or landlord.

pull: 1. The act of placing cable by pulling. 2. The longitudinal force acting on a pole as a result of horizontal loading.

pull cord: Cord placed within a cable pathway, used to pull wire and cable. *See drag line.*

pull strength: The rated strength of the force of a cable that can be exerted on it during the pulling process.

pull tension: The pulling force that can be applied to a cable without affecting specified characteristics for the cable.

raceway: Any enclosed channel designed for holding wires, cables, or busbars.

rack: *See cable rack.*

reel brake: A device used to control the rate of removal of a cable from a cable reel.

resistance: A measure of opposition a material offers to the flow of direct current.

return loss: 1. A ratio, expressed in dB, of the power of the outgoing signal to the power of the reflected signal. 2. The amount of reflected power compared to the amount of incident power at an interface, expressed in dB. Return loss is a critical factor in singlemode links because reflected light can destabilize some lasers.

reversed pair: When the polarity of the wires is reversed. A wiring error in twisted-pair cabling where the pins on a cable pair are reversed between connectors on one end of the cable.

ring: A means for identification of one conductor of a pair. Historically associated with the wire connected to the "ring" portion of an operator's telephone plug.

screened twisted-pair cable: A cable with one or more pairs of twisted copper conductors covered with an overall metallic shield. *See foiled twisted-pair cable.*

sheath: See cable sheath.

shield: Metallic layer placed around a conductor or group of conductors to prevent electrostatic or electromagnetic coupling between the enclosed wires and external fields.

shield: A continuous metallic layer placed around a conductor or group of conductors.

shielded twisted-pair cable: Cable made up of multiple twisted copper pairs, each pair with an individual shield. The entire structure is then covered with an overall shield or braid and an insulating sheath (cable jacket).

short: A low-resistance connection between two conducting materials.

singlemode optical fiber: An optical fiber, usually step-index grade, that supports only one mode of light propagation. This does not necessarily imply single-wavelength operation. The light source is normally a laser.

sleeve: A short section of conduit, either metallic or non-metallic, lining an opening in the wall or floor for cables to pass through.

space (telecommunications): An area used for housing the installation and termination of telecommunications equipment and cable (e.g., equipment rooms, telecommunications rooms, work areas, and maintenance holes/handholes).

splice: A joining of conductors in a splice closure, meant to be permanent.

splice case: A metal or plastic housing with a semicyclindrical cavity used in identical pairs to clamp around a cable splice to provide a closure.

splice closure: *See splice case.*

split pair: Inadvertent transposition of two conductors of separate pairs.

standard: A collection of requirements that encompass properties of components and systems that are intended to ensure an accepted degree of functionality and longevity. Standards are intended to reflect accepted norms as typically determined through a balloting process conducted by a nationally or internationally accredited organization.

STP-A: An IBM designed, shielded twisted-pair cable consisting of two individually shielded 22 AWG [0.64 mm (0.025 in)] conductor pairs, with an overall shield capable of supporting transmission to 300 MHz.

stub-out: Conduit installed from a wall outlet to a raceway.

stub-up: Conduit installed from a wall or floor outlet into the accessible ceiling space above.

surface-mounted raceway: Plastic or metallic raceway that is installed on the surface of a wall, floor, or ceiling. Provides a protective pathway for cables and/or power from public access.

suspended ceiling: A ceiling that creates an area or space between the ceiling material and the building structure above the material. This area may or may not be an air handling space requiring plenum rules of a national code. The design of the air conditioning/heating system determines this.

telecommunications: A branch of technology concerned with the transmission, emission, and reception of signs, signals, writing, images, and sounds; that is, information of any nature by cable, radio, optical, or other electromagnetic systems.

telecommunications entrance facility: *See entrance facility (telecommunications).*

telecommunications entrance point: *See entrance point (telecommunications).*

telecommunications entrance room or space: *See entrance room or space (telecommunications).*

telecommunications equipment room: ***See equipment room (telecommunications)*.**

telecommunications grounding busbar: A common point of connection for telecommunications system and equipment bonding to ground; located in the telecommunications room or equipment room.

telecommunications main grounding busbar: A busbar placed in a convenient and accessible location and bonded, by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

telecommunications outlet: See **outlet/connector (telecommunications)**.

telecommunications room: An enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and horizontal cabling.

telecommunications service entrance: *See entrance facility (telecommunications).*

tie wrap: Plastic or hook and loop strip used for binding and dressing cable.

trapeze: A support device using threaded rod and channel stock.

tray: *See cable tray.*

twisted-pair: Two individually insulated conductors physically twisted together to form a balanced pair.

twisted-pair cable: A multiconductor cable comprising two or more copper conductors twisted in a manner designed to cancel electrical interference.

underfloor raceway: A pathway placed within the floor and from which wires and cables emerge to a specific floor area.

unshielded twisted-pair cable: Cable containing one or more pairs of twisted copper without metallic shielding.

volt (V): A unit of electromotive force or potential difference that will cause a current of one ampere to flow through a resistance of one ohm.

wavelength: The length of a wave measured from any point on one wave to the corresponding point on the next wave, such as from crest to crest. The wavelength of light is usually measured in nanometers.

wire: An individually insulated solid or stranded metallic conductor.

wireway: A supported pathway for cables.

work area: A building space where the occupants interact with telecommunications terminal equipment.

work area outlet: A device placed at user workstation for termination of horizontal media and for connectivity of network equipment.

workstation: A telecommunications device used in communicating with another telecommunications device.

2.2 Acronyms, abbreviations, and units of measure

AHJ	Authority Having Jurisdiction
ATR	all-threaded-rod
AWG	American wire gauge
°C	degree Celsius
CP	consolidation point
CT	cable tray
dB	decibel
EF	entrance facility
ELFEXT	equal level far-end crosstalk
EMT	electrical metallic tubing
EP	entrance point
ER	equipment room
°F	degree Fahrenheit
FEXT	far-end crosstalk
ft	feet, foot
HC	horizontal cross-connect
HVAC	heating, ventilation, and air conditioning
Hz	hertz
IC	intermediate cross-connect
IDC	insulation displacement connector
IMC	intermediate metal conduit
in	inch
km	kilometer
kVA	kilovolt amp
LAN	local area network
lb	pound
lbf	pound-force
LED	light-emitting diode
m	meter
µm	micron; one millionth of a meter (0.000001 meter); also micrometer
MC	main cross-connect
MDF	main distribution frame
MHz	megahertz
mm	millimeter
MM	multimode
MUTOA	multi-user telecommunications outlet assembly
NEC®	*National Electrical Code®*
NECA®	*National Electrical Contractors Association®*
NEXT	near-end crosstalk
NFPA®	National Fire Protection Association®
PSELFEXT	power sum equal level far-end crosstalk
PSNEXT	power sum near-end crosstalk
RMC	rigid metal conduit
SC	subscriber connector
ScTP	screened twisted-pair
SM	singlemode
STP-A	shielded twisted-pair-A
TBB	telecommunications bonding backbone
TGB	telecommunications grounding busbar
TMGB	telecommunications main grounding busbar
TO	telecommunications outlet
TR	telecommunications room
USOC	Universal Service Ordering Code
UTP	unshielded twisted-pair
V	volt
X	cross-connect

3. Support Structures

3.1 General

Supporting structures are necessary to allow installation of wire, cable, connecting hardware, and associated apparatus. They are comprised of components such as equipment racks, cabinets, D rings, bridle rings, hangers, J hooks, plywood backboard, cable trays, conduits, slots, sleeves, and their associated hardware.

3.2 Pathways

3.2.1 General

When installing pathways, it is important to ensure that the route for the pathways are clear of obstructions, such as HVAC ducts, large pipes, and structural beams within the building. Where fire or smoke barriers are penetrated, they shall be firestopped to maintain the fire rating of the barrier.

Determine the entire route of a pathway before installation of the supports. The route shall be surveyed prior to installation to ensure that there are no obstacles. This is especially true when having to penetrate fire or smoke rated walls and floors. If the penetration cannot be established, then all the work done to install the support hardware may have to be repeated at another location.

Make penetrations through fire-or smoke-rated walls and floors before installing the hangers, clamps, and trapezes. Once the pathway is installed, firestop the penetrations per local code requirements.

3.2.2 Cable trays

This subclause specifically addresses the installation of a cable tray within a telecommunications room. The principles involved can be applied to installing cable trays between telecommunications rooms and as horizontal or backbone pathways.

3.2.2.1 Tubular construction

Tubular cable trays may be installed on one level or multiple levels. Corners and changes in horizontal plane are accomplished by using sections of cable tray cut from standard stock and connected together with manufacturer specified hardware. Connecting hardware permits all angles, both vertical and horizontal, to be accommodated over the entire route of the cable tray.

A tubular cable tray shall be wall mounted or supported by the building structure from above using all-threaded-rods (ATR) and manufacturer specified attachments *(See Figure 1)*. The all-threaded-rods shall be installed using properly sized anchors and correct attachment hardware. Select the ATR to support the maximum load for which the cable tray is designed. Figure 2 illustrates a tubular cable tray that is suspended from a ceiling using all-threaded-rods.

Wall brackets can support a tubular cable tray *(See Figure 3)*. Wall brackets are installed on a wall along the route of the cable tray. The number of brackets and specific spacing interval is dependent upon the load the cable tray must support. Supporting attachment shall be made on a cable tray not more than 610 mm (24 in) from the end, and at joints between two sections. Additional supports are also required every 1.5 m (5 ft) thereafter. Anchors to attach the brackets shall be sized to support the rated load of the cable tray.

Cable retaining posts are available in 150 to 300 mm (6.0 to 12.0 in) lengths to allow additional cables to be installed to a depth exceeding that of the cable tray. Without these devices the cable would not be confined by the edges of the cable tray and may fall from the tray. The load rating of the cable tray and support elements shall not be exceeded by the addition of cables to this pathway.

3.2.2.2 Rod stock

Installation of rod stock, commonly known as mesh cable tray *(See Figure 4)*, is accomplished by using light hand tools, power drills, and an offset blade bolt cutter. Unlike traditional cable trays, this system can be formed to adjust to changes in elevation and horizontal direction without the need for specialized adapters.

Mesh cable trays may be installed on one or multiple levels. Corners and changes in horizontal level are accomplished by selective cutting of the mesh in the cable tray at specific points using bolt cutters and connecting together the points cut by means of manufacturer specified attachment hardware. By using connecting hardware, all angles (both vertical and horizontal) can be accommodated over the entire route of the cable tray without having to sever the entire cable tray and use specialized hardware.

The mesh cable tray may be supported using wall brackets or all threaded-rods. Where appropriate, wall brackets are installed on the wall along the route of the cable tray. The brackets are installed at intervals depending on the rated load of the tray in accordance to manufacturer's guidelines. Support attachments shall be made on a cable tray not more than 610 mm (24 in) from the end, and at joints between two sections. Additional supports are also required every 1.5 m (5 ft) thereafter. Anchors to attach the brackets shall be sized to support the rated load of the cable tray.

3.2.2.3 Installation practices

Cable tray is installed from one wall to the opposite wall in a telecommunications room using wall angles to secure the cable tray at each end and by the manufacturer specified number of wall brackets to support the cable tray in the middle *(See Figure 5)*. By using both of these attachments, sufficient support for the cable tray and the installed cables is provided. Another choice to support the cable tray is by using all-threaded-rod attached to the building structure above.

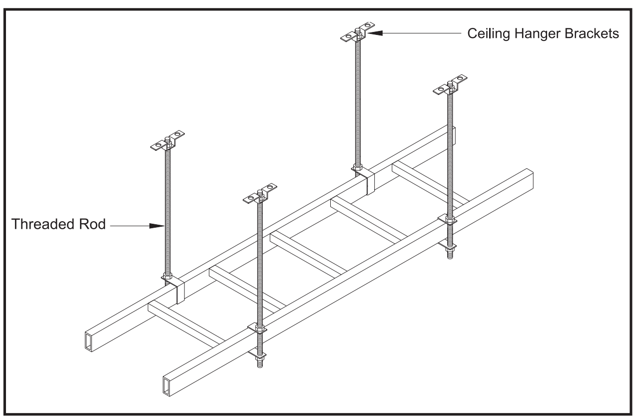

Figure 2. Suspended cable tray

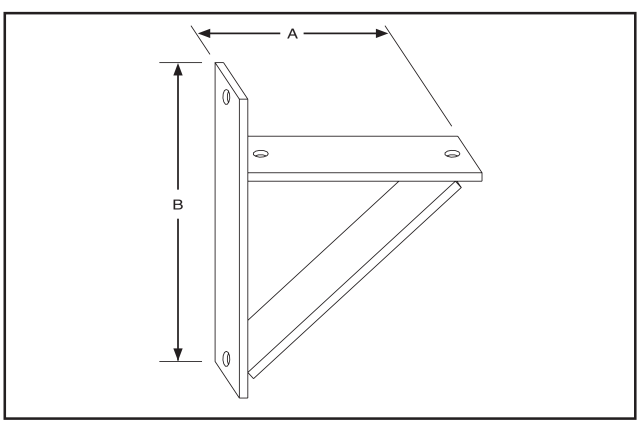

Figure 3. Wall bracket (Tubular)

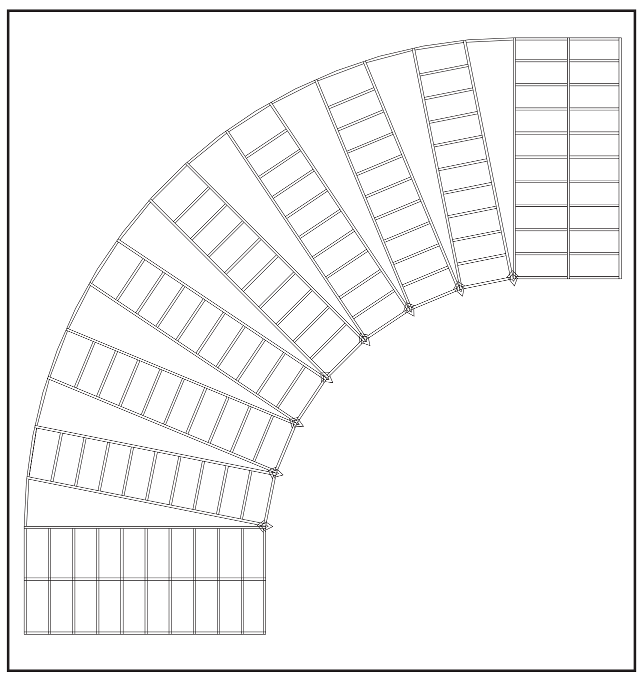

Figure 4. Mesh cable tray

3.2.3 D rings and mushrooms

D rings and half-D-rings are used to support small bundles of cables as they route from one termination point on the plywood backboard to another.

However, they should not be substituted for a cable tray. Mushrooms are typically used for cross-connect routing.

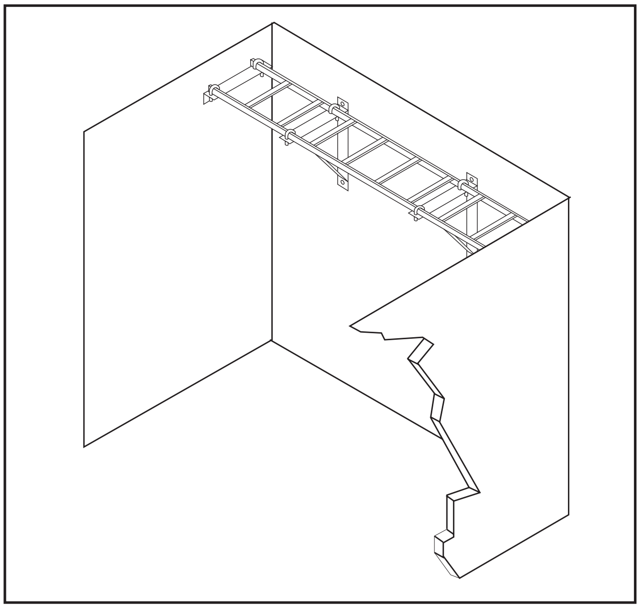

Figure 5. Elevation view of cable tray installed on the rear wall of a telecommunications room.

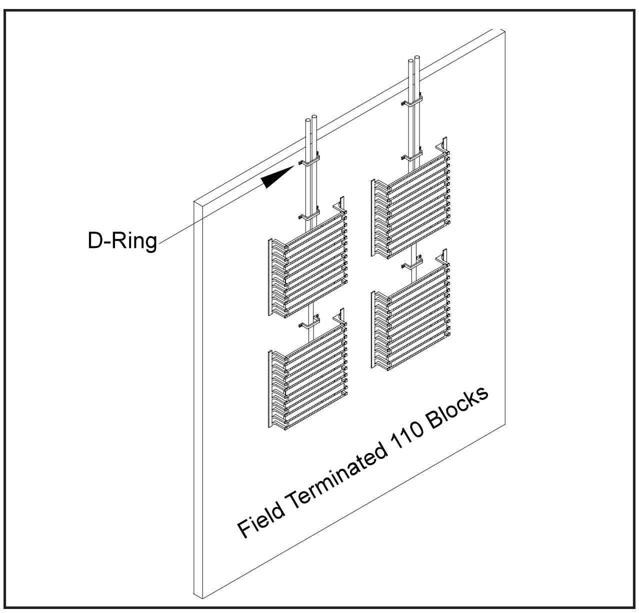

Figure 6. Typical backboard layout using D-rings

D rings are available in many sizes, shapes, materials, and colors. Traditionally, D-rings are manufactured of metal and are formed in the shape of the letter D. Figure 6 illustrates metal D-rings.

Mushrooms are constructed of plastic and contain a center-mounted screw for attachment to plywood backboards. They are also available with threaded bolts for installation on equipment racks. Figure 7 illustrates mushrooms.

3.2.4 Conduits

3.2.4.1 General

Conduits that enter a telecommunications room should be terminated on the wall to enable orderly routing of the cables to termination hardware within the room or routed through the room to another location. The telecommunications designer's drawings should indicate the location of each conduit and where they terminate in the room.

Conduit ends should be positioned adjacent to a corner of the backboard (in the case of a single piece of plywood) or in the corner of the room (where multiple sheets of plywood are installed around the perimeter walls of the room). If conduits cannot be located in these positions, cable trays should be used to route the cables from one location in the room to another.

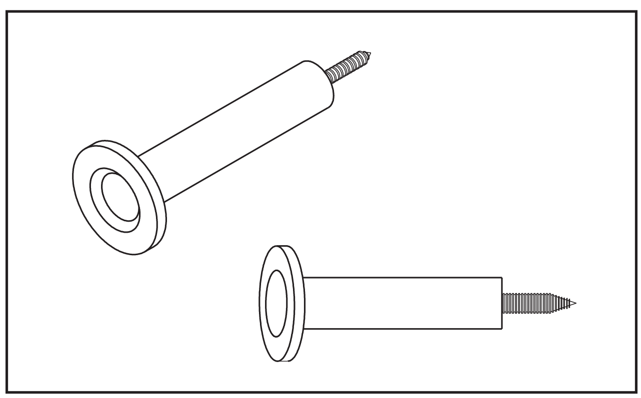

Figure 7. Mushroom

Where several large backbone cables are passing vertically through the room, a vertical cable tray or other suitable vertical attachments should be appropriately positioned to support the cables from ceiling to floor level. When cable tray is used, the cables should be secured to the cable tray in an orderly fashion to ensure that they are properly supported and the entire weight of the cable is equally distributed over several cable supports.

Conduits should be secured to the top of the plywood backboard when entering from overhead. When entering from below grade, extend the conduits 25 mm to 75 mm (1 in to 3 in) above the floor slab or building structure. Conduits shall be reamed and installed with bushings. It is especially important to use sweep elbows when installing bends. Reducing the recommended bending radius can result in cable damage. See Table 1 for minimum conduit bend radius.

The conduit brackets shall be of the type, which provide electrical continuity between the conduit and the channel stock to provide a bonding path between conduits and a bonding conductor to be installed from the channel stock. They shall then be bonded to either the telecommunications main grounding busbar (TMGB) or to a telecommunications grounding busbar (TGB) where present. Where a small number of conduits are installed, a grounding bushing should be installed at the end of each conduit for the attachment of a ground wire, which connects to the TMGB or TGB. Conduits in close proximity to each other can be bonded together and one of them shall be bonded to the TMGB or TGB.

Table 1. Minimum conduit bend radius

If the conduit has an internal diameter of...	The bend radius shall be at least...
50 mm (2 in) or less diameter	6 times the internal conduit diameter
More than 50 mm (2 in) diameter	10 times the internal conduit diameter

3.2.4.2 Elbows and bends

Factory-manufactured bends are recommended for conduit installation. Field-manufactured bends are typically elliptical (oval) in shape rather than completely round. This is caused by the action of the tools used to bend the conduit. Whenever possible, manufactured conduit sweeps should be used rather than mechanically bending the conduit in the field. See Table 1 for minimum bend radii of conduits.

3.2.4.3 Conduit terminations

Conduits should be terminated where they enter or leave a telecommunications room or equipment room. The recommended location for terminating the conduit is in a horizontal plane where the conduit penetrates the wall of the TR or ER. Allow no more than 50 mm (2 in) of conduit and bushing to extend into the room. Conduits that enter a telecommunications room should terminate in the corners to allow for cable racking. Terminate these conduits as close as possible to the wall where the backboard is mounted.

Conduits shall be reamed and bushed to reduce cable sheath damage during the pulling operation.

Conduits shall be bonded to ground. Grounding bushings are installed on the end of the conduit. With electrical metallic tubing (EMT), a set-screw grounding bushing is placed on the end of the conduit and tightened using the appropriate tool. On intermediate metal conduit (IMC) and rigid metal conduit (RMC), a grounding bushing is screwed onto the threaded end of the conduit. Tighten the bushing until it is secure. A threadless grounding bushing is also available which can provide an alternate means for locating the ground lug. These are installed with set-screws.

Other methods for securing conduits can be employed when conduits are turned down the wall and terminate at the top of the plywood or turned up and terminate at the bottom of the plywood.

Terminate conduits that protrude through the structural floor between 25-76 mm (1 3 in) above the surface. This prevents cleaning solvents or other fluids from flowing into the conduit.

When conduits are turned down in a telecommunications room, terminate them above the plywood backboard. This allows full usage of the plywood backboard for termination and routing of cabling. If this method is used, channel stock can be used to attach the conduits in a fixed manner to the room wall. Each conduit can be attached to the channel stock with a pipe clamp. If the pipe clamps are equipped with "teeth" that bite into the conduit, a grounding bushing is not required on every conduit. A single conduit in each run of channel stock can be equipped with a grounding bushing. The entire section of channel stock can effectively be grounded using a single bushing and ground wire. An alternative method is to install a grounding connection onto the channel stock and then route the ground wire to the appropriate ground bar (TMGB or TGB).

3.2.4.4 Securing conduit

Conduits shall be secured at each end in such a manner that they do not move. Cross braces can be used throughout the route to stabilize the conduit(s) and prevent movement. This can be accomplished by the use of conduit clamps, channel stock, or ATR placed at opposing angles (180-degrees opposite from each other). This helps prevent lateral movement of the conduit during placing operations. The same anchoring mechanisms can be used to secure the clamps and cross braces as used to hang the conduits from the building structure.

When large, high pair-count cables are installed in conduits, the pulling of the cable places significant tension on the conduit. A winch is generally employed in this high pair-count placing operation. Sometimes the winch is anchored to the building or attached directly to the conduit. This tension causes swinging and swaying of the conduit and its hangers. Excessive movement of the conduit can cause the hangers to loosen and possibly come free. If this happens, the conduit and its cable could fall to the floor resulting in damage to the cable, the building, and individuals.

3.2.4.5 Stub-up/stub-out conduits

These terms imply that a section of conduit is used to provide a pathway in a vertical and then horizontal direction from a point of termination. While similar in many ways, they are significantly different from an installation perspective.

3.2.4.5.1 Stub-up installation

Stub-ups are usually single sections of small diameter metal conduit. They originate at a single- or double-gang box installed in drywall or paneling. The stub-up continues vertically through the wall cavity where it penetrates the wall cap and stubs up into the ceiling area. It terminates at that point and is equipped with a conduit bushing and a pull string. Sometimes the stub-up is equipped with a 90-degree bend that is turned back into the room, especially when installed in fire- or smoke-rated walls.

3.2.4.5.2 Stub-out installation

Stub-outs are short runs of small diameter metal conduit. They originate at a single or double-gang box installed in drywall or paneling. The stub-out continues vertically through the wall cavity, where it penetrates the wall cap, and continues into the ceiling area. In a typical installation, the conduit continues through the ceiling area and into an adjacent hallway. The conduit may terminate as it exits the wall into the hallway, or it may continue to another type of supporting structure such as a cable tray or ladder rack. It terminates at that point and is equipped with a conduit bushing and a pull string.

3.2.5 Hangers

There are many types of hangers available to support the installation of conduit. Installation of pipe hangers is one such way that this can be accomplished. The hanger is a pear-shaped device that is attached to an ATR. An ATR is a length of rod stock that has been threaded for its entire length at manufacture. ATR is available in various lengths and diameters.

A pipe hanger is suspended from the building structure by an anchor and a section of ATR. The anchor is installed in the concrete structure of the floor or beam. When concrete is not available and steel trusses are installed in the building, beam clamps can be used to support the ATR and hanger. The selection of anchors and beam clamps should be determined by the load of the conduit and cable to be supported. The ATR is attached to the pipe hanger with nuts and lock washers. The assembly is then capable of supporting the conduit that is installed through the pipe hanger.

Another type of conduit support is a trapeze. This is a device that is made by using two ATRs and a section of channel stock. The ATR is suspended from the building structure and attached to each end of the channel stock using appropriate nuts and washers. The conduits are then attached to the channel stock with pipe clamps and locked in place.

A third type of conduit support is a one-piece conduit hanger. This is a device that is manufactured in such a way that the compression bolt is part of the hanger itself and, when loosened, it will not come off the hanger. This type of hanger can be mounted directly to the building structure, to red iron, or to a specialized hanger mount.

3.2.6 *Surface raceway*

Surface raceway is available in both metallic and nonmetallic versions. When installing surface raceway, follow manufacturer's instructions. Metallic surface raceway shall be grounded.

3.3 Spaces

3.3.1 *Plywood*

A minimum of two walls should be covered with rigidly fixed 20 mm (0.75 in) A-C plywood, preferably void free, 2.4 m (8 ft) high, capable of supporting attached equipment. Plywood should be either fire-rated or covered with two coats of fire retardant paint.

It is recommended that plywood backboards be installed around the entire perimeter of the room. This will allow cables to be installed and terminated around the walls of the room, now or in the future. It will also facilitate attaching cables that pass through vertically to rooms above or below.

Plywood sheets used for backboards should be installed with the longest dimension reaching from the floor level up toward the ceiling to its 2.4 m (8 ft) height. Plywood shall be installed in such a manner that there is no separation between adjacent sheets. When installing plywood in a corner, the plywood backboard shall be installed to form a smooth, tight-gap free corner.

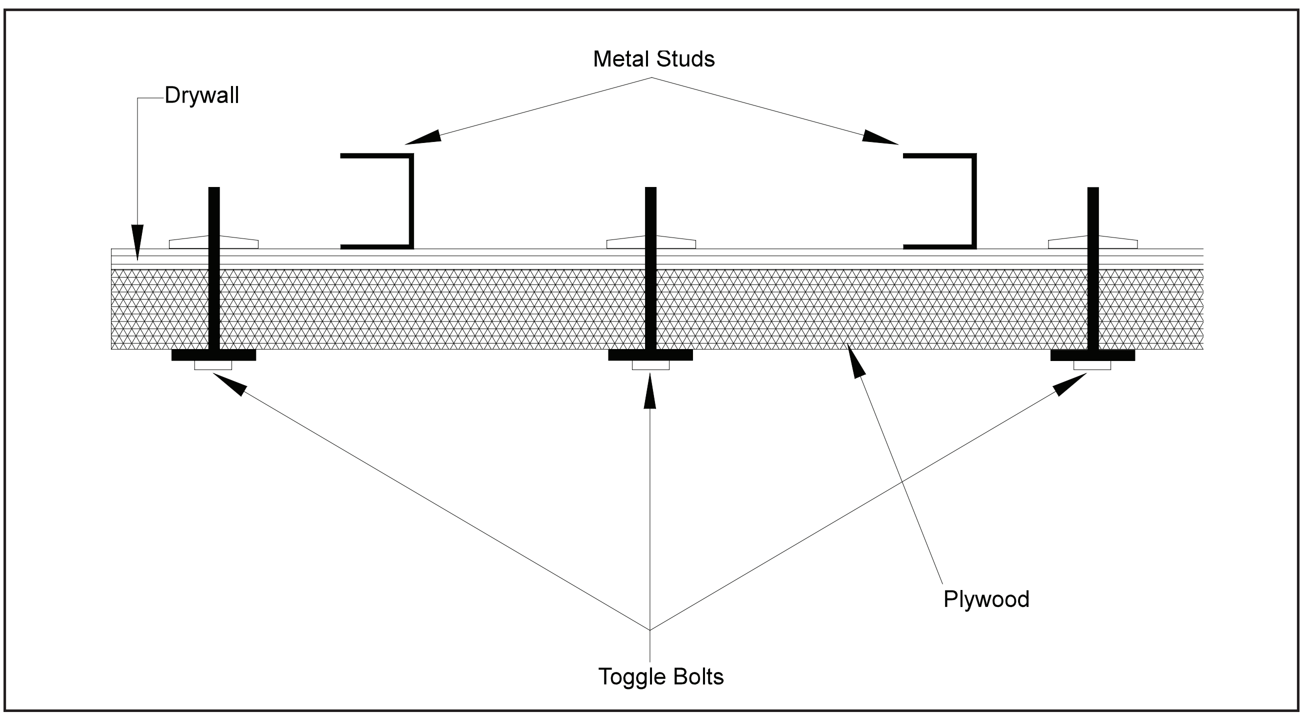

Figure 8. Plywood installation over drywall using toggle bolts

The plywood backboard shall be secured on top of existing drywall or to wall studs in the perimeter walls of the room. When installing plywood on drywall, which has already been installed on the studs, verify the load rating of the wall before installing the plywood. If the load rating will permit this type of installation, use 6 mm (0.25 in) toggle bolts (butterfly bolts) to ensure the stability of the installation. Toggle bolts should be installed at approximately 610 mm (24 in) spacing around the entire perimeter of the plywood sheet. The toggle bolts should be installed 50 mm (2 in) from the edges of the sheet of plywood on 610 mm (24 in) centers. Figure 8 illustrates plywood installation over drywall that is attached to metal wall studs.

3.3.2 Equipment racks

Racks shall be secured to the building structure and should be accessible from the front and rear. Typical spacing is 914 mm (36 in) in front and back of the rack, and 762 mm (30 in) on the sides.

Cables should be routed on the rear sides of the rack using cable management accessories attached to the rear of the rack's vertical channels or in cable management channels on the sides of the rack.

Where equipment racks are separated from a wall, cable trays should be installed from the wall to the top of the equipment racks. This will provide a pathway for cables to be routed between equipment racks. Transitions between cable trays and equipment racks shall be equipped with means ensuring minimum cable bend radii. All racks shall be bonded to the TGB or TMGB using a minimum 6 AWG copper conductor.

3.3.3 Floor mounted cabinets

Cable access to floor-mounted cabinets is normally provided by knockouts (pre-punched holes) in the cabinet side, top, or bottom. Cable trays and ladder racks provide a means of routing cables to the cabinet. Transitions between cable trays and cabinets shall be equipped with means ensuring minimum cable bend radii. Verify the cable installation methods specified by the manufacturer prior to attempting to install cabinets. Ensure that the cabinets will fit the footprint allocated for them prior to installation. If there is a question regarding the space allocated refer to design drawings or contact the designer for further clarification.

When floor-mounted cabinets are required, the grounding and bonding instructions shall be followed.

3.3.4 Wall mounted equipment racks and cabinets

When wall mounted equipment racks and cabinets are required, the grounding and bonding instructions shall be followed.

3.4 Bonding Infrastructure

3.4.1 General

Grounding and bonding are terms that are used to define the practice of connecting all metallic components of a system together to a main building ground electrode, for the purposes of reducing or eliminating the differences of potential between all of the utilities inside of the building structure. See ANSI/TIA/EIA-607.

3.4.2 Bonding conductor

Ground wires and a ground bus shall be installed so that they are not obstructed by cable trays, cables, or terminating hardware. Ground wires and bonding wires should always be installed in the straightest and shortest route between the origination and termination point. A minimum bend radius shall not be less than eight times the conductor diameter. A sharp bend may interfere with the effectiveness of the grounding system, since it will modify the characteristics of the grounding path.

3.4.3 Local code requirements

Local code requirements shall be followed. Always review the local code requirements with the local Authority Having Jurisdiction (AHJ) before proceeding with the installation. This includes reviewing what issue of the code is adopted and what, if any, exceptions to the code are adopted by the governing authority. Most of the code requirements for the job should be included in the telecommunications cabling designer's documents. The cabling installer should never take this information for granted, since the telecommunications contractor is fully responsible for all work done on the project.

If no code has been adopted locally, consult with the fire marshal's office to determine what agency is responsible for that geographic area and what codes are in effect. Do not depend on other cabling installers, contractors, or even company personnel in making these determinations.

3.5 Installing cable support systems

3.5.1 General

Cable support systems typically installed by the telecommunications installer include the following:

- Cable trays and associated hardware
- Ladder racks and associated hardware
- Enclosed wire pathways and associated hardware
- Plywood backboards, straps, rings, hangers, fasteners, and J-hooks
- Conduits and associated hardware

Support systems provide a pathway for the cable, thus reducing and eliminating stress, which could damage the copper pairs or glass strands inside a cable sheath. The following steps are general in nature. Additional steps may be required, depending on the size, quantity, and load rating of the individual supporting structures. Telecommunications designers should provide all the information in their design documents that will allow the cabling installer to select the necessary hardware and employ proper methods to install these structures.

3.5.1.1 Steps—install cable support systems

1) Obtain blueprint/specifications/designer's documents.
   - Determine the size, type, and quantity of pathways to be installed.
   - Determine the proposed route of the pathways between rooms and from rooms to work areas.
   - Identify any obstructions along the pro posed route and determine how to over come them.
   - If it is necessary to pass through any walls, be prepared to make the required penetration—concrete, concrete block, drywall, or other wall construction.
   - When installing cables in a suspended ceiling without permanent pathways, avoid cable paths that introduce obstacles.
   - Identify the plan to support cable in suspended ceilings and what type of hardware will be installed.

2) Verify load capacity of the cable support system.

   Verify this information by:
   - Reviewing the telecommunications designer's documents.
   - Determining the weight of individual types and sizes of cable to be installed.
   - Identifying the building structure to ensure the attachment of the support system is deigned for that structure.

3) Verify the load capacity of existing cable support structures where these are to be used.

   Visually examine the existing supports to de termine if they are firmly attached, not worn or broken, and are capable of bearing the extra weight.

4) Verify cable support installation accessibility.

   Examine the following:
   - Area where the building beams and other structural elements are located
   - Area where the concrete floor slab above is accessible and usable for installing anchors or other cable supports directly to them
   - Paths in all directions from the point of observation to see if the pathway is clear for cable supports

5) Cable separation.
   - Maintain specified distances from possible sources of EMI *(see Table 2)*.
   - For both safety and performance purposes, keep power cables physically separated from telecommunications cables.

NOTE: Route open or non-metallic telecommunications pathways a minimum of 127 mm (5 in) away from fluorescent fixtures.

6) Verify materials and tools availability.

Before beginning an installation of a cable support system, be sure that the required materials, hand tools, and power tools are available. This should also include safety tools such as safety glasses and, where required, hardhats.

7) Mount D-rings.
   - Review the designer's drawing and specifications to determine exact placement, quantity, size, and type of D-rings.
   - Install the D-rings, working from the top left side of the plywood backboard to the bottom right side of the plywood backboard:
     – Measure the location of the first D ring to be installed according to the designer's documents.
     – Position the D ring on the backboard and mark the location of the holes in the D ring.
     – Pre-drill the location of the D ring holes.
     – Position the D ring on the backboard and install screws.

8) One method of mounting J-hooks in structures above the suspended ceiling level.
   - Determine the J-hook size required in each cable path and lay them out along the cable route (maximum of 1.2 m to 1.5 m [48 in to 60 in]).
   - Identify the location of the first J-hook to be installed.
   - Position the J-hook at its designated location and mark the holes for the anchors.
   - Pre-drill the holes and install the anchors (depending on the type of structure, i.e., a masonry structure will require one type of anchor while metal structures or drywall will require others).

Table 2. Minimum separation distances from possible sources of EMI

Condition	Minimum separation distance		
	< 2kVA	2-5 kVA	>5kVA
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	127 mm (5 in)	305 mm (12in)	610 mm (24 in)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5 mm)	152 mm (6 in)	305 mm (12 in)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	— —	76 mm (3 in)	152 mm (6 in)
Electrical motors and transformers	—	—	1220 mm (48 in)

- Install the anchors.
- Reposition the J-hook at the desired location.
- Using a screwdriver, install the screw through the hole in the J-hook and into the anchor, securing the J-hook to the anchor.
- Repeat the above for the second screw.
- Install the remaining J-hooks using the same procedures, until all J-hooks are installed.

9) Install cable tray systems.

The process of installing cable tray is manufacturer specific, due to the many different sizes, types, and configurations. The cabling installer must consult the manufacturer's specifications and installation guidelines prior to attempting to install these pathways.

Trays can be installed parallel to and against a wall or can be suspended from the building structure using all-threaded-rods. They can also be supported using channel stock or manufacturer specific hanger brackets.

Since these pathways are used to support both backbone cables and horizontal cables, they are found in most areas of the buildings. It may be the case that other utilities (i.e., HVAC, plumbing, electrical) or structural obstructions will require that the pathway change elevation and direction. Careful planning is important to minimize changes in direction which can be costly from a material as well as labor perspective.

10) Install conduits.

See ANSI/TIA/EIA-569-A for maximum length of conduit and bends between pull points and pull box sizing.

All metal conduits installed for the placement of telecommunications cable shall be bonded to ground.

11) Conduit hangers.

Conduits are suspended from the building structure using a variety of hangers. These hangers are available in many sizes and types depending on the type of conduit and method used to install the hangers. The cabling installer should refer to the manufacturer's specifications for use of the type and size for the conduit to be installed.

12) Installing wireway.

Wireways are different from cable trays in that they are completely enclosed pathways. They usually feature a hinged cover or one which snaps in place. They are available in a number of sizes and shapes, depending on the manufacturer. As with cable trays, the installation methodology is directly related to the manufacturer's guidelines. All metallic wireways installed for the placement of telecommunications cable shall be bonded to ground per the *NEC*.

13) Pathway documentation.

The pathway shall be identified not only on the drawings, but each pathway should also be physically equipped with a label that identifies it and states where it originates and terminates. See ANSI/TIA/EIA-606.

14) General housekeeping.

It is important to clean up behind a work operation when installing pathways. Larger equipment is required to install these pathways and the materials themselves are bulkier, taking up more space in the hallways and passageways of the building. This causes congestion and, if left in place, can impact the work efforts of other trades.

The hangers, their associated hardware, anchors, screws, and other materials present a safety hazard to workers and should be stored during work operations and upon completion of the day's activities. If a work area cannot be completely cleaned, safety cones and barricades should be placed to prevent accidental intrusion into the work area by others until the work is complete and the area is cleaned.

4. PULLING CABLE

4.1 General

Backbone cable usually has higher pair counts (25 to 2400 pairs) and weighs more than horizontal cables. For vertical pathways, cabling is more easily installed from the top down than from the bottom up because gravity helps with the pull. It is the preferred method.

The type of equipment needed depends on the direction of the pull. If pulling from the bottom up, a winch may be needed. If pulling from top down, a reel brake may be needed. A reel brake is a mechanical device used to stop or slow a free-wheeling reel, thus keeping it from unreeling too fast due to gravity.

Two-way communication with coworkers is essential in every cable pull. Everyone should be prepared to alert the person pulling the cable, to ensure the cable is traversing the route smoothly without twisting, kinking, or getting bound up in some way.

All penetrations through fire-rated walls and floors shall be firestopped according to local code requirements.

4.2 Cable pulling setup

4.2.1 Overview

A good cable setup means all materials are in place so the cables can be handled properly. A cabling contractor may need specialized equipment capable of holding large reels. Smaller equipment, such as cable trees, may be used to handle the many reels of cable containing low pair count cable.

4.2.2 Pulling horizontal cable in conduit

4.2.2.1 Overview

Horizontal cable is installed between the telecommunications room and work area outlets. Cable shall not be bent or kinked.

Conduit installations are usually designed to be parallel or perpendicular to the external walls of the building. No one conduit segment shall be more than 30 m (100 ft) in length with no more than two 90-degree bends allowed in one segment. Exceeding these limits increases the coefficient of friction in the cable pulling operation and can damage the cable by possibly stretching or changing the cable geometry. Placement of horizontal cabling in conduit may require the use of a cable pulling lubricant. Always label cables and their reels prior to pulling cable into place. It is easier to identify and label the cables before they are pulled through the conduit.
As-built plans shall be provided to the owner as a permanent record.

4.2.3 Pulling horizontal cable in open ceiling

4.2.3.1 General

The procedure for cable installations in open ceilings is different from that in conduits. Cables shall be supported according to local code requirements and manufacturer provided instructions.

4.2.4 Pulling backbone in vertical pathway—from top down

4.2.4.1 General

Backbone cable is typically a high-pair-count cable, or high-strand-count optical fiber cable.

When cable is received at the job site, the cable length should be verified. Inspect both ends of the cable to verify the footage markings on the outer jacket and compute the actual length of the jacket. This is the recommended method for verifying cable length.

Pulleys may be needed to handle the cable from the reel location to the point where it will be lowered to lower floors. In the room where the cable will enter the vertical pathway, a bullwheel may be required to ensure that the jacket is not damaged as it enters the pathway.

The use of cable lubricants can significantly reduce friction and speed cable installation. A lubricant should be selected based on cable manufacturer's recommendations. The cable should then be identified, labeled, and the as-builts updated to reflect the work operation.

4.2.5 Pulling backbone in vertical pathway—from bottom up

4.2.5.1 General

Cable sheaves may be necessary to handle the cable from the reel location to the point where it will be pulled up to upper floors. In the room where the cable will enter the vertical pathway, a bullwheel may be required to ensure that the jacket is not damaged as it enters the pathway. Cabling installers should be located on each floor through which the cable will pass as well as the top floor where it will terminate. These individuals shall be equipped with tools to perform critical tasks during the placing operation.

The use of cable lubricants can significantly reduce friction and speed cable installation. A lubricant should be selected based on cable manufacturer's recommendations. The cable should then be identified, labeled, and the as-builts updated to reflect the work operation.

4.2.6 Pulling backbone—horizontal

4.2.6.1 General

Backbone cable may be used to interconnect telecommunications rooms on the same floor. Cable support mechanisms are required.

Cable sheaves may be necessary to handle the cable from the reel location to the point where it will be pulled. In the room where the cable will enter the horizontal pathway, a bullwheel may be required to ensure that the jacket is not damaged as it enters the pathway.

The use of cable lubricants can significantly reduce friction and speed cable installation. A lubricant should be selected based on cable manufacturer's recommendations. The cable should then be identified, labeled, and the as-builts updated to reflect the work operation.

4.2.7 Pulling optical fiber cable

4.2.7.1 General

While the optical fiber cable is on the reel, the installer should verify that there is optical continuity. This can be done by shining a light source (such as a flashlight) into the fiber strands or using a power meter or optical time domain reflectometer (OTDR). Optical fiber cable is more rugged than generally perceived; however, just as with copper cable, the manufacturer's recommended pulling tension and minimum bend radius shall not be exceeded. The pathway of a fiber cable must be free of sharp bends and turns. Innerduct may be placed inside conduit, through sleeves, or placed in cable trays to facilitate additional cable pulls in the future and to relax pulling tension exerted on the cable.

Complete the pull and route the cable to the rooms. Identify and document on the cable as-built drawings.

5. FIRESTOPPING

5.1 General

Reestablishing the integrity of fire-rated walls, floors, and ceilings is an essential part of a cabling installer's job.

The cabling installer shall use manufacturer approved methods to restore the original rating of the fire rated architectural structures and assemblies to any penetrations made during the installation and any holes created by the removal of existing penetrations. See ANSI/TIA/EIA-569-A, Annex A for information regarding firestops.

The term firestop refers to the installation of "qualified" firestop materials in holes made through fire-rated floors, walls, or ceilings for the penetration of pipes, cables, or other construction/building, service/utility items. Firestop products are used to restore the opening to the original fire-rated integrity. Most common requirements are for 1, 2, or 3 hours. In rare instances, a 4-6 hour rating shall be provided.

There are two basic types of penetrations:

- Through penetration is a hole made in a fire-rated wall or floor to run pipes, cables, or any type of building service, completely through from one side of the fire barrier to the other side.
- Membrane penetration is a hole in one side of a fire-rated wall or floor for a single surface-barrier penetration. (i.e., an electrical outlet/switch box).

Therefore, the cabling installer:

- Cannot substitute products that are not part of the qualified assembly.
- Cannot add more of a product to get a higher rating.
- Can be held personally responsible for improperly firestopping or not firestopping.
- Should contact the manufacturers to get written assistance for situations not covered in their installation practices for qualified assemblies.

There are ten basic types of firestop products:

1. Mechanical systems
2. Mortar/compounds
3. Composite sheets
4. Collar/devices
5. Blankets
6. Caulks/sealants
7. Putty
8. Wrap strips
9. Pillows/bags
10. Sprays

5.1.1 Mechanical firestop systems

Mechanical systems consist of manufactured elastomeric components presized and shaped to fit around standard cables, tubes, and conduits. These products are made of several substances which resemble rubber and are flexible. These systems use mechanical pressure to hold the elastomeric components in place and to provide a tight seal around the penetrating devices. Whether or not frames are included, some means of applying compression to the modules is required.

5.1.1 Nonmechanical firestop systems

Nonmechanical firestop systems are generally pliable. These include items such as putties, caulks, blankets, silicone foam, pillows, and other types of materials that can be molded to fit into an opening to seal it.

5.2 Typical installations

5.2.1 Sealing a floor penetration with putty

The following illustrations show an example of installing a putty seal from one side of a floor penetration.

1) Tear off a small portion of the putty.

NOTE: Use a drop cloth or other cover to protect the floor surface from the putty and insulation material. See Figure 9.

2) Use the putty to build a bottom in the penetration, according to the manufacturer's instructions. *See Figure 10.*

3) Fill the penetration with ceramic fiber or rock wool fill, stopping far enough from the upper rim to allow for a top layer of putty at the manufacturer's recommended thickness. *See Figure 11.*

4) Use the putty to build a top on the penetration, according to the manufacturer's instructions. *See Figure 12.*

5.2.2 Sealing an outlet box with putty

To seal an outlet box, follow the steps below.

1) Press a pad of putty into place, covering one side of the outlet box. Ensure that the pad overlaps at the top, bottom, and sides, as shown. *See Figure 13.*

2) Press a second pad of putty into place on the other side of the box, as shown. *See Figure 14.*

3) Press the seams together to join the two pads, as shown. *See Figure 15.*

5.2.3 Steps—restore penetrations (general)

1) Firestop conduits, pipes, and innerducts in brick, concrete block, or concrete wall. *See Figure 16.*

The requirements for firestopping are variable and are directly dependent upon:

- Fire-barrier construction.
- Material passing through the firewall.
- Hourly rating required.

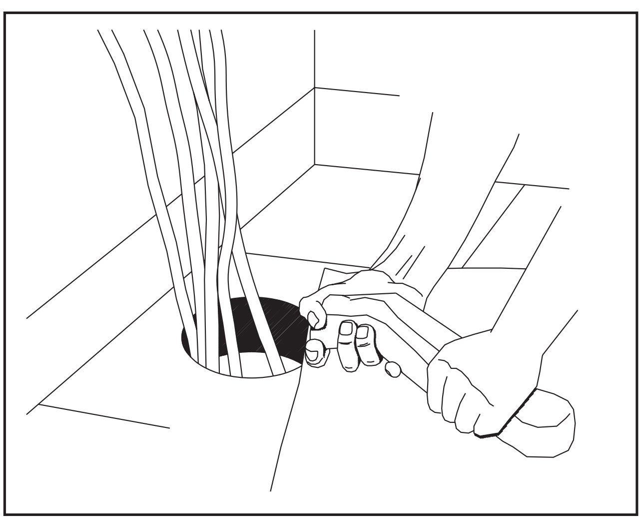

Figure 9. Tear off putty

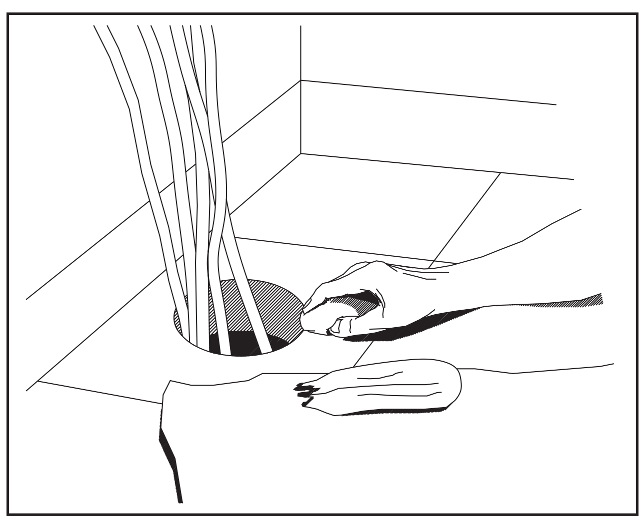

Figure 10. Building bottom of penetration seal

- Opening size.
- Installing the materials according to manufacturer-tested methods.

2) Firestop floor penetrations.

Sealing of cored or sleeved openings in floor slabs containing pipes, cables, or innerducts requires knowledge of floor thickness, floor construction, hourly fire rating required, opening size, annular space, sleeves, and materials selection.

3) Firestopping drywall. *See Figure 17.*
   - Requirements for firestopping are variable and are directly dependent upon hourly rating, opening size, annular space, and sleeves.
   - Drywall penetrations are typically required to have firestopping installed symmetrically on both sides of the wall to restore fire rating.

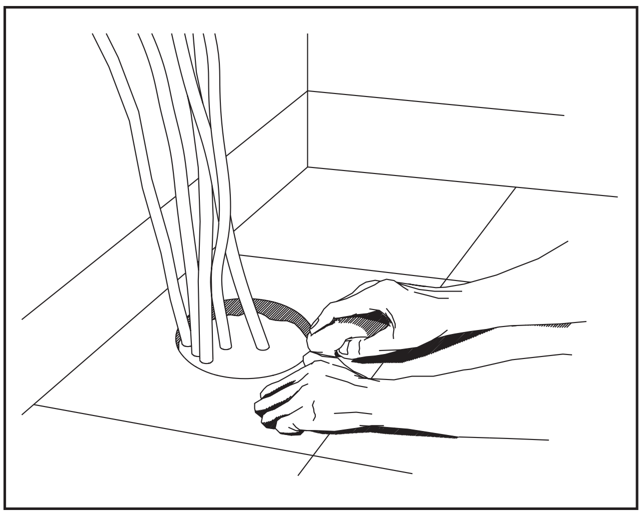

Figure 11. Filling the penetration

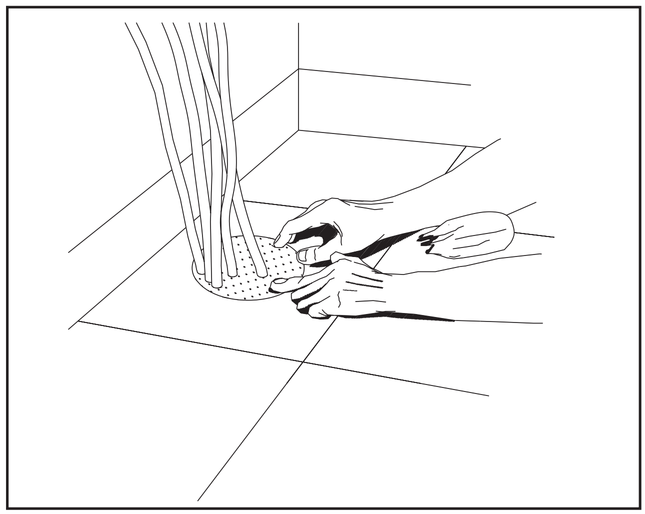

Figure 12. Building top on penetration

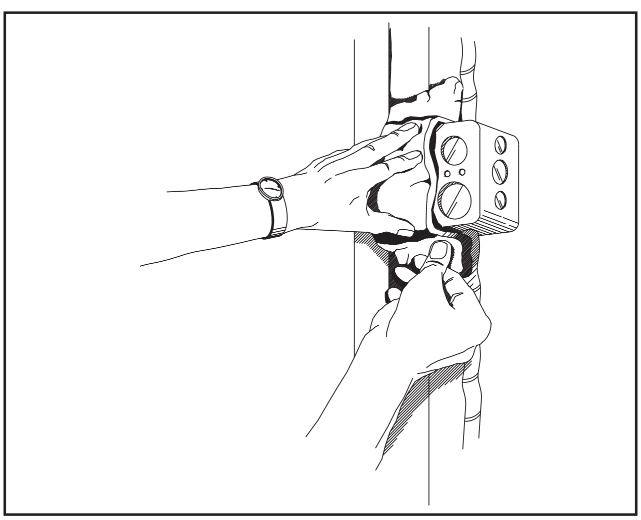

Figure 13. Overlap the pad on outlet box

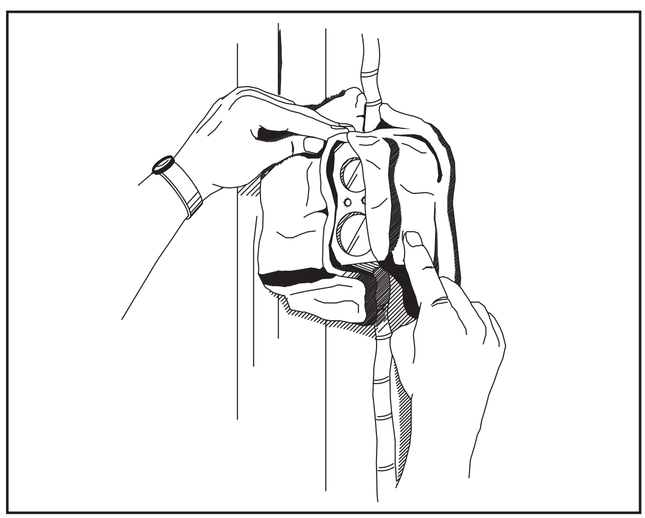

Figure 14. Second pad of putty on outlet box

4) Firestopping all applicable penetrations.
   - Inspect all cable runs for any openings made through fire-rated walls as part of structured cabling system.
   - If sleeves have been used, be sure to firestop the wall penetrations on both sides and each end of the sleeve itself.

5) Firestop cable tray.

Penetration by a cable tray in a firewall is only permitted by the Authority Having Jurisdiction. Generally the tray is placed against each side of the firewall and a number of appropriately sized sleeves are installed for cables to pass through.

If a cabling installer encounters a cable tray penetration directly through firewalls, specifically manufactured seal systems should be obtained. Figure 18 demonstrates the components of a qualified seal system.

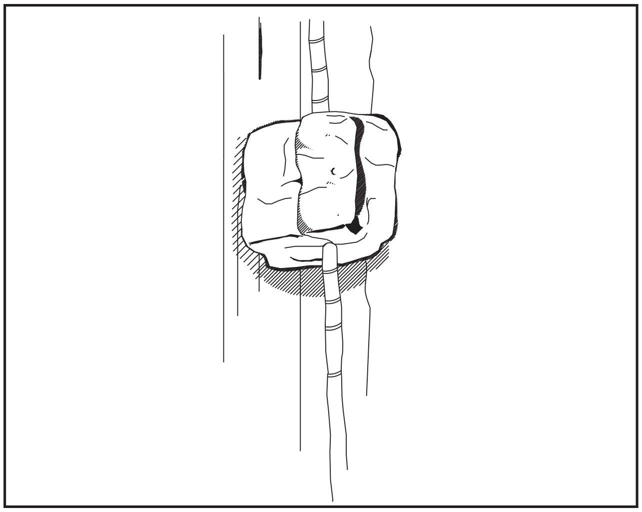

Figure 15. Joining the pads on an outlet box

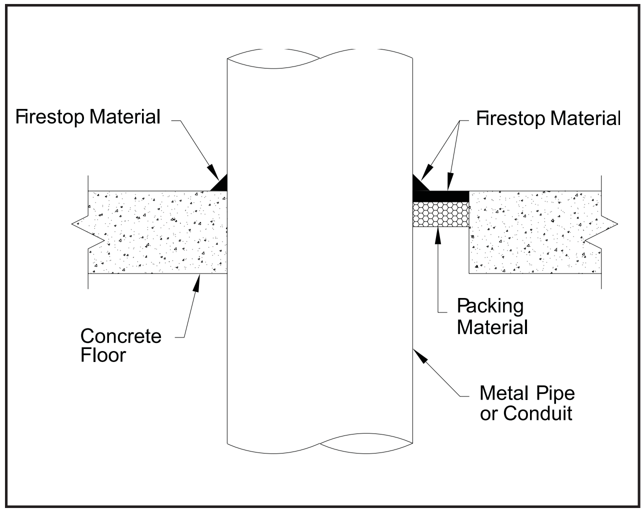

Figure 16. Conduit penetration through masonary wall or floor

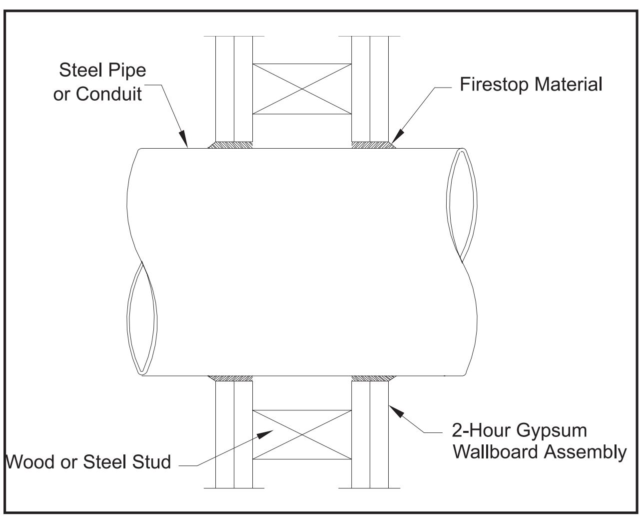

Figure 17. Fire seal of drywall

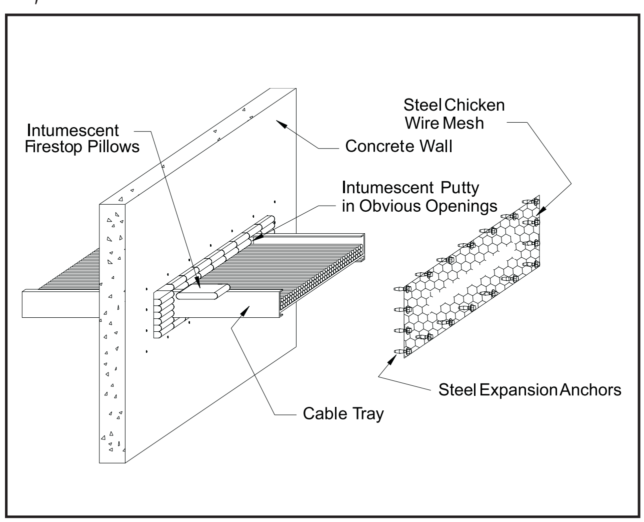

Figure 18. Fire seal cable tray penetration

6. Cable Terminations

6.1 General

Cable termination involves the organizing of cables by destination, forming and dressing cables, and labeling, as well as actually creating a connection with a copper or fiber conductor.

Optical fiber cores need to be precisely aligned with the fiber core of the connecting cable or within the connecting hardware to ensure that the maximum transfer of light energy is obtained.

Never look into the ends of an optical fiber as the light may damage your eyes. Because the light is invisible to your eye, serious damage to the retina of the eye is possible.

Insulation Displacement Connection (IDC) termination is the recommended method of copper termination recognized for UTP cable terminations.

Only the T568A and T568B wiring schemes comply with the ANSI/TIA/EIA-568-B.1 standard *(see Figure 19)*. Another common pin/pair assignment for telephony is designated as Universal Service Ordering Code (USOC). Each of the wiring schemes is shown in Figure 19.

6.2 Pre-termination functions

6.2.1 General

Preparation for cable termination not only improves the quality of the job but also decreases the amount of time required for termination.

The performance of pre-termination functions involves organizing the cable by destination. Cable to be terminated should be placed at the point of termination and must also be identified to ensure it is terminated in the designated position.

Forming and dressing the cable involves aligning and positioning the cables in a neat and orderly manner for termination. The length of cable needed to reach the termination location must be determined, taking into account enough slack to re-terminate if necessary and not placing undo pulling stress on the termination.

Cable management results in neat and orderly bundles of cables that are formed into a symmetrical pattern. Besides being aesthetically acceptable, cable management provides support and mechanical protection of the pairs.

Cable connection is not complete until all terminations are identified and labeled.

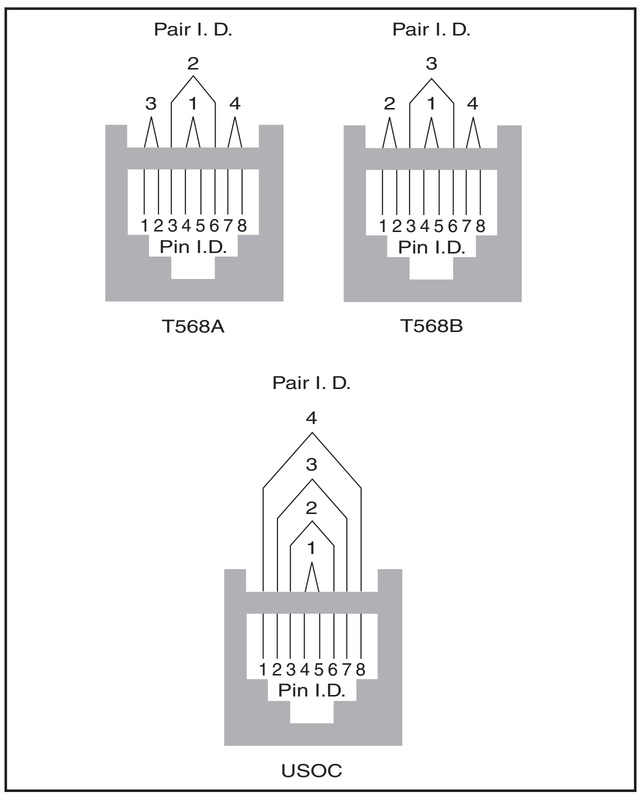

Figure 19. Wiring schemes

6.3 Copper IDC termination

Copper terminations can be used for UTP and ScTP cabling. ScTP manufacturers provide detailed instructions on how to terminate the shield. This procedure is manufacturer dependent, and the specific method provided for the selected product shall be followed for shield effectiveness over the capable bandwidth.

6.3.1 Steps—IDC termination

1) Using a sheath removal tool, remove the cable sheath in accordance with the termination equipment manufacturer's specifications.

2) Binder groups are found in 50-pair cables and above. Separate and identify binder groups. *See Table 3*.

Table 3 — Color-code chart up to 600 pair

Pair number	Tip	Ring	Binder group	Pair count
1	white	blue	white-blue	001-025
2	white	orange	white-orange	026-050
3	white	green	white-green	051-075
4	white	brown	white-brown	076-100
5	white	slate	white-slate	101-125
6	red	blue	red-blue	126-150
7	red	orange	red-orange	151-175
8	red	green	red-green	176-200
9	red	brown	red-brown	201-225
10	red	slate	red-slate	226-250
11	black	blue	black-blue	251-275
12	black	orange	black-orange	276-300
13	black	green	black-green	301-325
14	black	brown	black-brown	326-350
15	black	slate	black-slate	351-375
16	yellow	blue	yellow-blue	376-400
17	yellow	orange	yellow-orange	401-425
18	yellow	green	yellow-green	426-450
19	yellow	brown	yellow-brown	451-475
20	yellow	slate	yellow-slate	476-500
21	violet	blue	violet-blue	501-525
22	violet	orange	violet-orange	526-550
23	violet	green	violet-green	551-575
24	violet	brown	violet-brown	576-600
25	violet	slate		

1. Limit the untwisting of cable pairs to the minimum length required to make the termination. The untwist of cable pairs shall not exceed 13 mm (0.5 in).
2. Terminate cable according to connecting hardware manufacturer's recommendations.

6.4 Shielded twisted-pair (STP-A)

The STP-A cable is a 150 ohm shielded 300 MHz cable comprised of two individually shielded 22 AWG twisted pairs in either a plenum or non-plenum-rated sheath. Each of the two pairs are shielded by a mylar wrap, and both pairs are then shielded with a braided shield which encompasses the cable.

Ensure that the connector selected matches the physical and electrical requirements of the cable being installed. If the STP-A connector is used, all grounding should be completed per the manufacturer's specifications.

Universal data connectors are generally provided with detailed written and visual instructions for termination procedures. A simplified version of these steps is as follows:

6.4.1 Step – terminating universal data connectors

1) Strip cable jacket to shield.

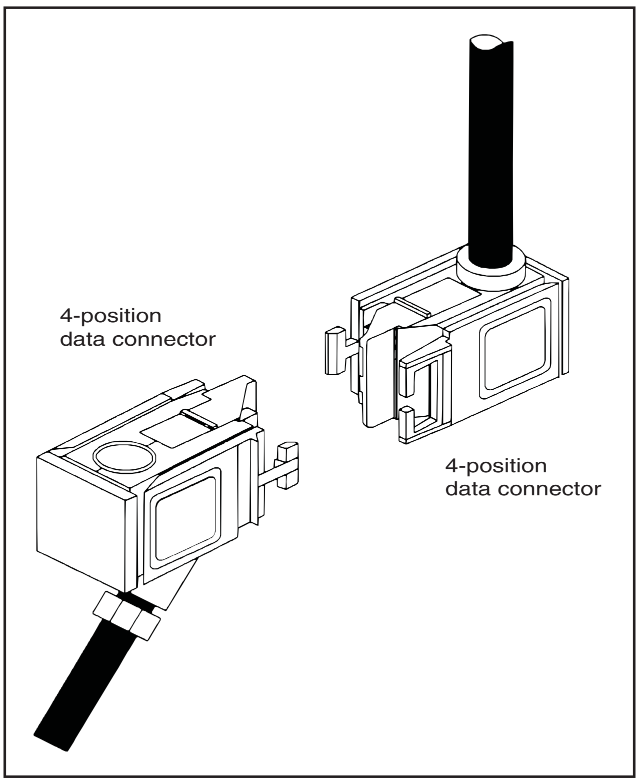

Figure 20. STP-A Data connector

2) Slip ring over shield.

3) Mate color-coded wire to color-coded clear plastic dressing block. (red, green, black & orange)

4) Snap dressing block into housing; seat firmly with pliers.

5) Snap housing cover into place.

6.5 Optical Fiber termination

6.5.1 General

In telecommunications, there are two specific types of optical fiber used: multimode and singlemode. Each specific type of fiber has its own characteristics.

Multimode optical fiber has an outside diameter of 125 μm. The glass core of the fiber, which carries the optical signal, has a diameter of 50 μm or 62.5 μm. Singlemode optical fiber has an outside diameter of 125 μm. The glass core of the fiber, which carries the optical signal, has a diameter of 8-9 μm.

Termination procedures for optical connectors in the field vary by manufacturer. Several common methods are:

- Heat-cured termination: A fiber connector termination method using an adhesive that requires heat for curing.
- Crimp termination: A fiber connector termination method using a mechanical means to secure the fiber.
- Anaerobic termination: A fiber connector termination method using an adhesive and catalyst that cures very quickly.

Optical fibers within cables are color coded as shown in Table 4.

6.6 Copper cable splicing

Intrabuilding copper cable splicing is allowed only in backbone cable—never for horizontal cable which extends between the telecommunications room and the work area.

Two common modular (groups of pairs) splicing techniques are in-line and foldback. Foldback splicing is the preferred method, where practicable cable.

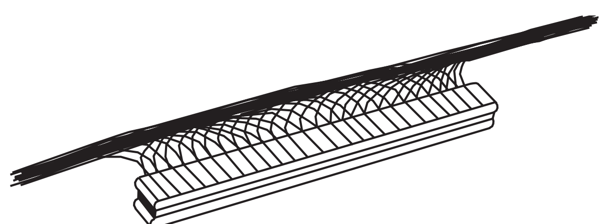

Figure 21. In-line splice configuration

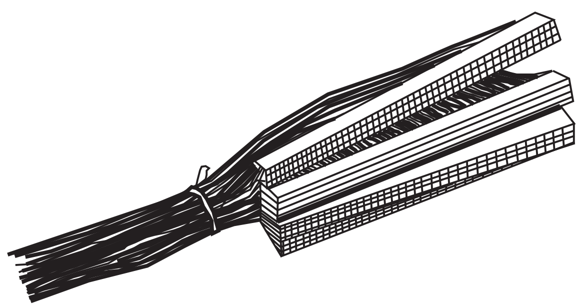

Figure 22. Foldback splice configuration

With the in-line splicing method, wire is placed in a straight-across arrangement and provides for little wire slack *(see Figure 21)*. The in-line method is not designed to be rearranged and should receive minimum handling. The foldback splicing method allows the conductors to be folded into the splice which in turn provides for maintenance, rearrangement, and transfer of the conductors. The foldback method *(see Figure 22)* typically requires more cable be stored within the splice and could increase the size of the needed splice closure.

The splice hardware will be selected by the designer to meet the application requirements. Follow the equipment manufacturer's installation guidelines.

The installer should pay particular attention to:

- Check cable shield for presence of unsafe voltages.
- Bond cable shields across the splice before splicing *(see Figure 23)*.
- Bond cable shields to ground.

Table 4. Optical fiber color code chart (ANSI/TIA/EIA-598-A)

Fiber Number	Color	Fiber Number	Color
1	Blue	13	Blue/Black Tracer
2	Orange	14	Orange/Black Tracer
3	Green	15	Green/Black Tracer
4	Brown	16	Brown/Black Tracer
5	Slate	17	Slate/Black Tracer
6	White	18	White/Black Tracer
7	Red	19	Red/Black Tracer
8	Black	20	Black/Yellow Tracer
9	Yellow	21	Yellow/Black Tracer
10	Violet	22	Violet/Black Tracer
11	Rose	23	Rose/Black Tracer
12	Aqua	24	Aqua/Black Tracer

6.7 Optical fiber cable splicing

There are two major categories of field-splicing methods for optical fibers—fusion and mechanical. Both single-fiber and multiple-fiber (typically 12 fibers) splicing methods are available.

Multimode fiber shall not be spliced to singlemode fiber since the splice loss will be unacceptable.

The splice hardware will be selected by the designer to meet the application requirements. Follow the equipment manufacturer's installation guidelines.

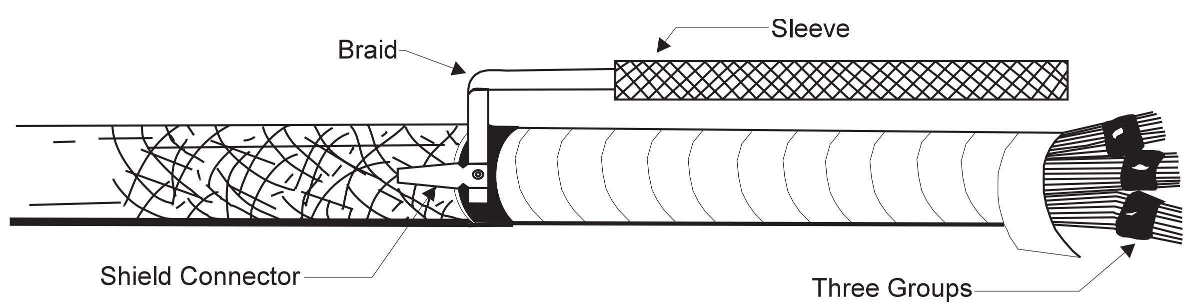

Figure 23. Shield bond connector and braid

7. INSTALLATION VERIFICATION

Installation verification is a systematic method utilized to ensure that the installation has been completed in accordance with all of the terms and conditions of the contract and industry standards.

Visual inspection and documentation are required for verification of proper installation practice. See ANSI/TIA/EIA-606 for administrative requirements. When performance verification with a field tester is required, follow the procedures in Annex A of this standard.

This annex is normative and is considered part of this Standard.

ANNEX A (NORMATIVE) FIELD TEST REQUIREMENTS

A.1 General

Transmission performance depends on cable characteristics, connecting hardware, patch cords and cross-connect wiring, the total number of connections, and the care with which they are installed and maintained.

Field test instruments shall be calibrated and maintained at intervals specified by the manufacturer.

A.1.1 Administration

All test data shall be recorded and provided to the building owner or agent.

A.2 100-Ohm UTP cabling

A.2.1 Test instruments

For field testing of categories 3, 5 and 5e cabling, test instruments shall meet or exceed the applicable requirements in ANSI/TIA/EIA-568-B.1. Commercially available test instruments which specify ANSI/TIA/EIA-568-B.1 Level I or Level II or Level IIe accuracy are required for validation that installed cabling meets the transmission characteristics found in ANSI/TIA/EIA-568-B.1.

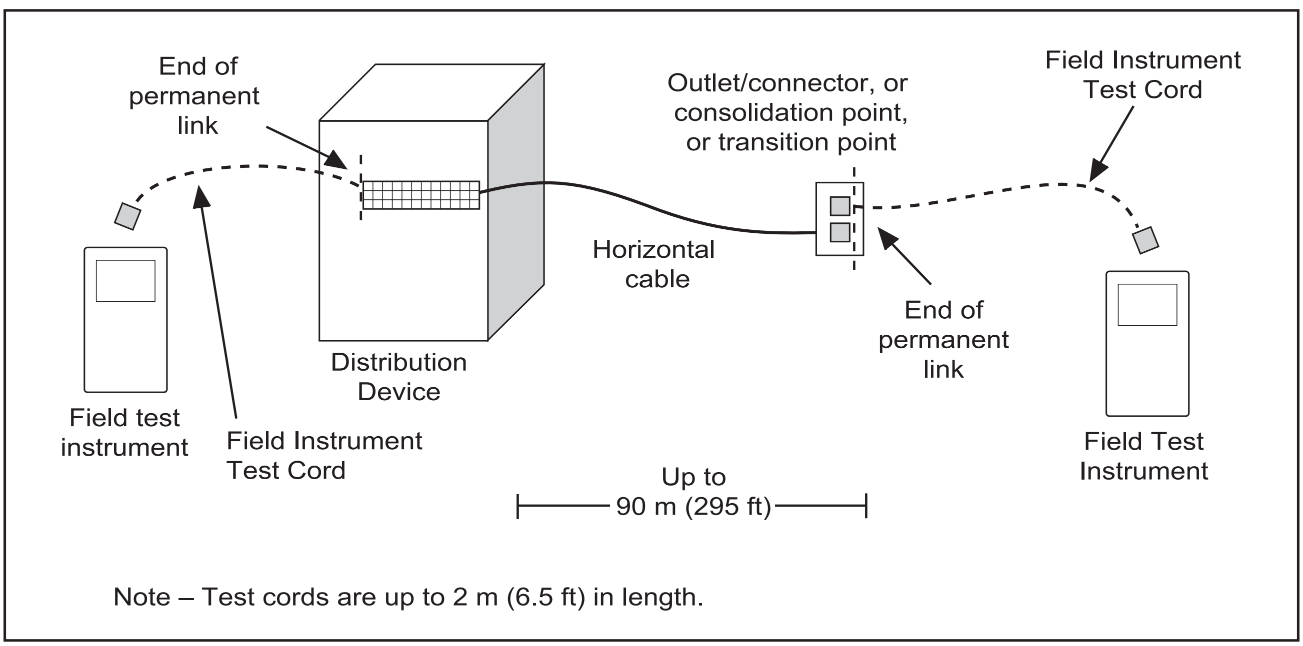

Figure 24. Permanent link test configuration

A.2.2 Performance parameters

The field tests required for UTP cabling are as follows:

- Wire Map
- Length
- Attenuation
- Near-end crosstalk (NEXT) loss

Additional field tests required for category 5e are as follows:

- Power sum near-end crosstalk (PSNEXT) loss
- Equal level far-end crosstalk (ELFEXT)
- Power sum equal level far-end crosstalk (PSELFEXT)
- Return loss

A.2.3 Permanent link test configuration

The cabling shall be verified in accordance with the permanent link test configuration *(See Figure 24).*

A.2.4 Channel test configuration

The channel shall be verified in accordance with the channel test configuration *(See Figure 25).*

A.2.5 Backbone and other cabling test configuration

The wire map test for all pairs in backbone and other than horizontal cabling shall be performed and recorded for all segments. Wire map tests include:

- Continuity to the remote end.
- Shorts between any two or more conductors.
- Crossed pairs.
- Reversed pairs.
- Split pairs.
- Any other miswiring.

The length of each backbone cable segment should be measured and recorded.

A.3 Optical fiber cabling

A.3.1 Test instruments

Field testers for multimode optical fiber shall meet the requirements as specified in ANSI/EIA/TIA-526- 14A, Method B, One Jumper Reference.

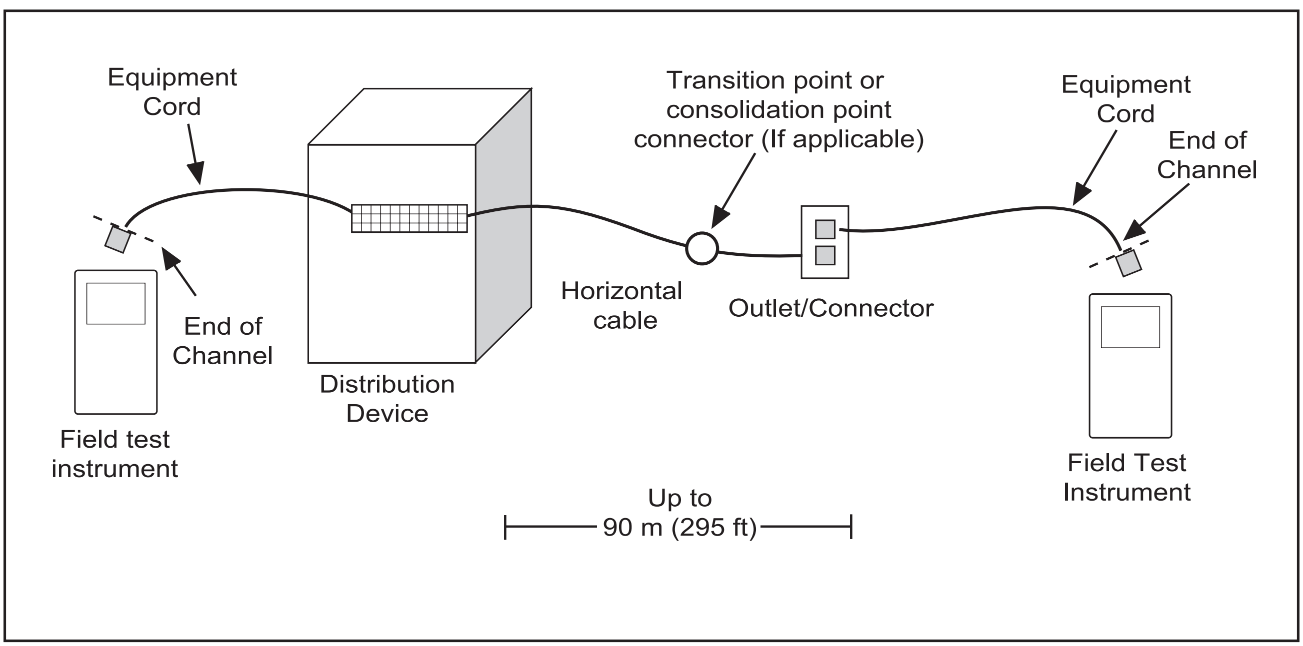

Figure 25. Channel test configuration

NOTE – Link attenuation has been based upon the use of a light source categorized by a coupled power ratio of Category 2, Underfilled, per Annex B of ANSI/EIA/TIA-526-14A. The use of a light source categorized as Category 1, Overfilled, may provide results higher than the 2.0 dB. The user is advised to consult ANSI/EIA/TIA-526-14A, specifically Annex B and C, for further information concerning the affects of modal power distribution and coupled power ratio.

Field testers for singlemode shall meet the requirements as specified in ANSI/EIA/TIA-526-7, Method A.1, One Jumper Reference.

A.3.2 Performance parameters

Field tests required for cabling are as follows:

- Length.
- Polarity.
- Attenuation.

A.3.3 Horizontal cabling test configuration

Horizontal cabling shall be verified in accordance with ANSI/TIA/EIA-568-B.1.

A.3.4 Backbone cabling test configuration

Backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-B.1.

(This annex is not part of this standard.)

ANNEX B (Informative): Bibliography and References

This annex contains information on the documents that are related to or have been referenced in this document. Many of the documents are in print and are distributed and maintained by national or international standards organizations. These documents can be obtained through contact with the associated standards body or designated representatives. The applicable electrical code in the United States is the *National Electrical Code*.

ANSI/EIA/TIA-492AAAC, Detail Specification for 50 µm Core Diameter/125 µm Cladding Diameter Class of Multimode, Graded-Index Optical Waveguide Fibers

ANSI/EIA/TIA-455-A-1991, Standard Test Procedures for Fiber Optic Fibers, Cables and Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components

ANSI/TIA/EIA-492AAAA-A-1998, Detail Specification for 62.5 µm Core Diameter/125 µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

ANSI/TIA/EIA-492CAAA-1998, Detail Specification for Class IVa Dispersion-Unshifted Singlemode Optical Fibers

ANSI/TIA/EIA-526-7-1998, Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant-OFSTP 7

ANSI/TIA/EIA-526-14-A-1998, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant OFSTP 14A

ANSI/TIA/EIA-604-3-1997, FOCIS 3 Fiber Optic Interconnector Intermateability Standard

ANSI/TIA/EIA-568-B Series 2001, Commercial Building Telecommunications Cabling Standard

ANSI/TIA/EIA-569-A-1998, Commercial Building Standard for Telecommunications Pathways and Spaces

ANSI/TIA/EIA-598-A-1995, Optical Fiber Cable Color Coding

ANSI/TIA/EIA-606-1993, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

ANSI/TIA/EIA-607-1994, Commercial Building Grounding and Bonding Requirements for Telecommunications

ANSI/TIA/EIA-758-1999, Customer-owned Outside Plant Telecommunications Cabling Standard

ANSI X3.166-1990, ANSI Standard for Token Ring FDDI Physical Layer Medium Dependent (PMD)

ANSI Z136.2-1997, Standard for the Safe Operation of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources

ASTM B539 90, Measuring Contact Resistance of Electrical Connections (Static Contacts)

Bellcore GR 1503CORE, March 1995, Bellcore Generic Requirements for Coaxial Connectors (Series 59, 6, 7 and 11)

BICSI Telecommunications Distribution Methods Manual

BICSI Telecommunications Cabling Installation Manual

BICSI Customer-Owned Outside Plant Design Manual

Federal Communications Commission (FCC) Washington D.C., "The Code of Federal Regulations, FCC 47 CFR 68"

FIPS PUB 174, Commercial Building Telecommunications Wiring Standard

ANSI/ICEA S-80-576-1994, Communications Wire and Cable for Wiring Premises (ANSI)

ANSIICEA S-83-596-1994, Fiber Optic Premises Distribution Cable (ANSI)

ANSI/ICEA S-87-640-1992, Fiber Optic Outside Plant Communications Cable (ANSI)

IEC 60603-7, 1996, Detail Specification for Connectors, 8 Way, Including Fixed and Free Connectors with Common Mating Features

IEEE C2-1997, National Electrical Safety Code (ANSI)

IEEE C 62.11, Metal Oxide Surge Arrestors for AC Power Cicuits (ANSI)

IEEE 802.3-1990 (also known as ISO 8802-3: 1990 (E), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications (ANSI)

IEEE 802.4, Standard for Local Area Network Token Passing Bus Access Method, Physical Layer Specification

IEEE 802.5-1992 (also known as ANSI/IEEE Std 802.5-1992), Token Ring Access Method and Physical Layer Specifications

IEEE 802.7-1989 (R1997) IEEE Recommended Practices for Broadband Local Area Networks (ANSI)

NEMA 250-1997, Enclosures for Electrical Equipment (1000 Volts Maximum) (ANSI)

NFPA 70-1999, National Electrical Code (ANSI)

SCTE, IPSSP001, June 13, 1996, Flexible R.F. Coaxial Drop Cable

SCTE, IPSSP100, January 14, 1997, Specification for Trunk, Feeder and Distribution Coax Cable

SCTE, IPSSP401, October 10, 1997, "F" Port (Male Feed Thru) Physical Dimensions

SCTE, IPSSP404, October 10, 1997, “F” Connector (Male Indoor) Installation and Performance

TIA/EIA TSB 31 B, FCC 47 CFR 68, Rationale and Measurement Guidelines

The organizations listed below can be contacted to obtain reference information.

American National Standards Institute (ANSI)
25 West 43rd Street
New York, NY 10036 USA
(212) 642-4900

American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959 USA
(610) 832-9500

BICSI
8610 Hidden River Parkway
Tampa, FL 33637-1000 USA
(800) 242-7405

Electronic Industries Alliance (EIA)
2500 Wilson Blvd., Suite 400
Arlington, VA 22201-3836 USA
(703) 907-7500

Telecommunications Industry Association (TIA)
2500 Wilson Blvd., Suite 300
Arlington, VA 22201-3836 USA
(703) 907-7700

Federal Communications Commission (FCC)
Washington, DC 20554 USA
(301) 725-1585

Federal and Military Specifications (FIPS)
US Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161 USA
(703) 487-4650

Insulated Cable Engineers Association, Inc. (ICEA)
PO Box 440
South Yarmouth, MA 02664 USA
(508) 394-4424

International Electrotechnical Commission (IEC)
Sales Department
PO Box 131
3 rue de Varembe
1211 Geneva 20 Switzerland
+41 22 34 01 50

NOTE — IEC documents can also be obtained from ANSII

The Institute of Electrical and Electronic Engineers, Inc® (IEEE®)
IEEE Service Center
445 Hoes Ln., PO Box 1331
Piscataway, NJ 08855-1331 USA
(732) 981-0060

The Institute for Interconnecting and Packaging Electronic Circuits
3451 Church Street
Evanston, IL 60203 USA
(847) 509-9700

International Organization for Standardization (ISO)
1, Rue de Varembe
Case Postale 56
CH-1211 Geneva 20 Switzerland
+41 22 34 12 40

NOTE — ISO documents can also be obtained from ANSI

NEMA
National Electrical Manufacturers Association® (NEMA®)
1300 N. 17th Street, Suite 1847
Rosslyn, VA 22209 USA
(703) 841-3200

National Fire Protection Association® (NPPA®)
Batterymarch Park
Quincy, MA 02269 USA
(617) 770-3000

Society of Cable Telecommunications Engineers (SCTE)
140 Philips Rd.
Exton, PA 19341-1318 USA
(800) 542-5040

Telcordia™ *(formerly Bellcore)*
Telcordia Customer Service
8 Corporate Place Room 3C-183
Piscataway, NJ 08854-4156 USA
(800) 521-2673