

Telecommunication Facility Design Guidelines

Duke University – Office of Information Technology (OIT)

I. INTRODUCTION

Duke University has a multitude of voice, data, and video requirements that rely on a wiring infrastructure that is of quality design, reliable, and flexible, to meet the ever changing demands of its educators, medical staff, and researchers.

This document is designed to inform planners, architects, engineers, and contractors of the minimum infrastructure requirements of Duke University and Duke University Health System. These requirements must be met for all on- and off-campus Duke Facilities.

A. PLANNING AND DESIGN

1. During the planning and implementation stages of any new facility or renovation, engineers and architects will come into contact with one or several representatives from Duke's two communications service providers: Office of Information Technology (OIT) and Duke Health Technology Solutions (DHTS) These two groups are interested in providing a high quality, consistent infrastructure, and bring expertise to the complex world of communications at Duke.
2. Renovation projects are quite different in nature from new construction and require very early consultation with an OIT representative. This early consultation will ensure all existing and future communications distribution system requirements are addressed.
3. For ease of coordination, please contact an OIT analyst below or the project manager. In turn, they will coordinate a team of communications engineers, technicians, and support personnel to meet the scope of the project. It is extremely important that a representative from OIT be contacted during the early planning stages to ensure all aspects of communications requirements are met.
4. The diversified communications options vary from building to building and require a great deal of planning. The team will work with the occupants, contractors, and project managers during the planning stages, and provide them with the space requirements for communications room(s), distribution design assistance/approval, and cost estimates.
5. For all on- and off-campus University and Health System buildings, contact either of the following:

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B. RESPONSIBILITIES

1. On campus, the electrical contractor is responsible for pulling all voice, data, and video intra-building backbone and horizontal cable as specified in the construction documents. The electrical contractor is responsible for the purchase and installation of the approved raceway system.
2. OIT is responsible for supplying all voice, data and video backbone and horizontal cable. OIT will hire a telecommunication contractor to terminate, label and test all cable. OIT will provide voice and data equipment and materials to up fit the telecommunications rooms.
3. For off-campus locations, OIT will contract the wiring through a bid proposal. OIT will provide a budget for these costs.

II. **BUILDING COMMUNICATIONS SERVICE ENTRANCE**

Every new University or Health System building must be tied into the existing underground conduit duct system for voice, data, and video communications.

A. ROUTING OF UNDERGROUND CONDUIT

All inter-building communications cabling on the Duke campus is installed in underground ducts encased in concrete. This duct system follows a master plan developed several years ago with the University Architect, and is placed in designated utility corridors. OIT is responsible for the design, installation, and budget of the underground duct system up to the manhole outside of a new building. During the design process, OIT will specify the route and building entrance location.

1. Number of Conduits required

OIT will assist in developing the best size and number of conduits, to anticipate ultimate requirements for service and emergency needs. Construction drawings shall

provide a minimum of four 4" conduits extending from a manhole (typically located 5' 0" outside the building) and terminating in the building's Telecommunications Entrance Room as described later in this document.

2. Conduit

Where the entrance conduits penetrate the foundation, footings, or outside walls of a building, rigid metallic conduit shall be used. Plaster fiber ducts or aluminum conduit are not acceptable. These conduits shall have a minimum of 2' 0" ground cover at the point of exit. A downward slope must be maintained to the manhole to prevent water from draining into the building.

3. Sealing Conduit

Seal all conduits inside the building to prevent rodents, water, or gases from entering the building.

4. Bends

Seal all conduits inside the building to prevent rodents, water, or gases from entering the building. Bends in conduit runs must not exceed 180° between manholes or other access points. The total number of bends in a conduit section run must not exceed two 90° bends or equivalent of sweeps and radius bends. All bends must be long, sweeping bends, with a radius not less than ten times the conduit's diameter. For example, a 4" conduit would have a minimum sweep of 40".

5. Pull Strings

Seal all conduits inside the building to prevent rodents, water, or gases from entering the building. Bends in conduit runs must not exceed 180° between manholes or other access points. The total number of bends in a conduit section run must not exceed two 90° bends or equivalent of sweeps and radius bends. All bends must be long, sweeping bends, with a radius not less than ten times the conduit's diameter. For example, a 4" conduit would have a minimum sweep of 40".

B. BUILDING FEED CABLES

Each building must have inter-building copper, fiber, and coaxial cabling to provide voice, data, and video services. Contact OIT for a cost estimate of the cable. OIT will also serve as contractor for the cable installation.

III. TELECOMMUNICATIONS ENTRANCE ROOM

The telecommunications entrance room serves as the demarcation (known as "demarc") location for the building. It is the transitional point from the voice, data, and video building feed cables to intra-building backbone cable, which runs to each communications room. The telecommunications entrance room contains electronic equipment and can double as the communications room for the area of the building around it. Connecting conduit or raceway

systems are required to ensure that the greatest distance from any telecommunications outlet to the nearest communications room does not exceed 295 linear feet or 90 linear meters.

OIT will design and budget for the cable support system according to minimum standards for off-campus building locations. These specifications will be included in the bid documents to the telecommunications contractor.

A. LOCATION

1. General

The telecommunications entrance room for each building is typically in the basement and must be located on a bearing wall, which reduces the possibility of relocating the room if the building is expanded or altered. Do not locate the telecommunications entrance room in any place that may be subject to water infiltration due to flooding, steam infiltration, humidity from nearby water or steam, heat, or any other corrosive atmospheric or environmental conditions. Do not allow utilities except those serving the room to run above or in this room [for example, HVAC ducts, electrical service planes, plumbing lines (water, soil, or steam)].

2. Relation to Communications Rooms

Locate the telecommunications entrance room in such a place as to provide a riser for all other communications rooms in the building.

3. Electromagnetic Interference

Do not locate the telecommunications entrance room near equipment that can cause electromagnetic interference (EMI). Keep electrical feeders and branch circuits of noisy equipment away from sensitive equipment and its associated circuits. Likely sources of EMI are heavy-duty electromechanical equipment (for example, copiers, door openers, and elevator systems).

B. SIZE

The telecommunications entrance room must be a minimum of 150 sq. ft. (minimum width 10') and provide a 32" clearance on each side for 19" equipment racks, on which data electronics and power equipment are normally mounted. This room size will provide service to approximately 20,000 square feet of building.

C. RISERS

Vertical cable risers make for ease of design, construction, and maintenance. Provide a riser with a minimum of four 4" conduits or sleeves to each communications room. The total number of conduits or sleeves depends on the number of floors in the building and on the number of tenants/outlets required in the building.

Architects and engineers shall include a single line riser diagram of all conduits as part of the construction documents and drawings. An OIT representative shall review the conduit sizes and details of this drawing.

1. Entrance to the Telecommunications Entrance Room

Locate the riser entrance in a corner of the telecommunications entrance room. Conduit or sleeves must extend far enough below the ceiling to permit installation of a bushing and cap. In the communications room above, the conduit should extend a minimum of 3" above the finished floor.

Conduits entering the telecommunications entrance room shall penetrate the room walls at no less than 8' 0" above the finished floor and extend one to two inches into the room with bushings. The telecommunications contractor will provide and install overhead ladder racks to support the horizontal wire.

2. Riser Cable

The electrical contractor is responsible for determining the length of and pulling, all voice, data, and video communications cabling. This shall include:

- a. All intra-building backbone cable for voice, data, and video communications between the telecommunications entrance room and each communications room.
- b. All horizontal cable for voice, data, and video communications between the communications room and each communications outlet.

The electrical contractor shall label all cable pulls in the communications room with the end-termination room number (for example, for room 101, label pulls 101-1, 101-2 etc.).

An OIT representative will determine placement and route of cable drops in each communications room. Each cable run shall include a minimum of 25' of slack in the communications room and 12" of slack at the communications outlet.

3. Firestopping

Firestopping is to be placed on the outside of all conduits and sleeves installed into cored holes. The telecommunications contractor is responsible for firestopping the inside of all risers when penetrating floor slabs or fire-rated walls. Unused conduits and sleeves shall be capped.

D. ELECTRICAL REQUIREMENTS

Communications systems have strict requirements for electric power. To ensure reliable service, adhere to the following guidelines.

1. Lighting

Fluorescent light fixture(s) are required. Fixture(s) shall be located to provide adequate lighting with an illumination of no less than 50 foot candles at 3' 0" above the finished floor. A wall switch should be located near the door.

2. Power Requirements

Provide a minimum of two 20-ampere/120 volt dedicated circuits terminated on quad outlet boxes. Provide one 20-ampere/120 volt dedicated circuit terminated in 3000-wire mold mounted horizontally across the bottom of the 19" racks. In Health System buildings, provide one additional 30-ampere/120 volt dedicated circuit terminated in the wire mold with a twist lock NEMA L5-30R connector for the Uninterrupted Power Supply (UPS).

3. Grounding

Supply a power ground or building ground connection utilizing a minimum #6 green copper conductor as close as possible to the service entry conduits. Leave a wire coil the length of the floor to the ceiling, plus 6' 0", in the room.

4. Emergency Power

If emergency power is available in the building, all power circuits and lighting in the telecommunications entrance room shall be connected to this service. The electrical contractor shall indicate on drawings whether a generator or a UPS provides emergency power.

E. STRUCTURE REQUIREMENTS

1. Door

Provide double 6' 0" wide, 7' 6" high solid doors (no center post and no seal) with 180° hinges, mounted to swing outside the room, if possible, according to code.

2. Floor Coverings

To keep dust and static electricity to a minimum in the telecommunications entrance room, use floor finishes of asphalt tile, linoleum tile, or cement sealers. Carpeting is not permitted.

3. Walls

The walls of the telecommunications entrance room must extend from the finished floor to the regular ceiling and be rated fire resistant. They must support loading of 200 pounds; this load can occur every two feet at 5' 6" above the finished floor.

4. Wall Covering

All interior wall surfaces shall be lined with unpainted, pressure-treated, fire-retardant 3/4" plywood 8' high. These plywood panels shall be installed a minimum of 6" above a finished floor. Anchors for plywood panels shall be sufficient to support all background equipment apparatus.

5. Ceiling

Ceilings must be at least 8' 6" high to provide adequate space over the equipment frames for cables and suspended racks. False ceilings are not permitted in the telecommunications entrance room.

6. Environment

Older telephone equipment was generally stable in most environments; new electronic communications systems are more sensitive to environmental conditions and typically have strict operational requirements. The temperature of the telecommunications entrance room must be maintained between 64° and 75°F. The relative humidity range must be between 30% and 55%.

A minimum of 15,000 BTUs of cooling is required. A thermostat located within the room and 5' 0" above the finished floor shall control the cooling system. The room shall be positive with respect to corridor or area adjoining these rooms. Auxiliary air conditioning units may be required in rooms with high volumes of voice, data, and video electronics.

7. Fire Protection

Fire alarm equipment and circuit terminations are often co-located with communications equipment. Fire alarm infrastructure and operation requirements are separate and in addition to OIT standards. For specific information on fire alarm requirements, contact the Fire Safety Division at (919) 684-5609.

8. Card Readers

Card and electronic access equipment and circuit terminations are often co-located with communications equipment. Card and electronic entry reading infrastructure and operation requirements are separate and in addition to OIT standards.

For all University buildings, contact the Duke Card office at (919) 684-5800.

For all Health System buildings, contact Medical Center Engineering and Operations at (919) 684-4004.

IV. COMMUNICATIONS ROOMS

Communications rooms house intra-building backbone cables and serve as a distribution point for horizontal cabling. The physical size of a building determines the need for communications rooms. The length of the horizontal standard cabling for voice, data and video is limited to 295 linear feet or 90 linear meters from the room to the communications outlet.

A. LOCATION

Communications rooms shall be vertically stacked with relation to one another. They shall be interconnected with a riser system using sleeves or conduits. The room shall be located off a corridor or an area not associated with business offices or high activity areas. Restrooms and all other water, soil, and steam sources shall not be designed on any side of or above the communications rooms.

B. SIZE

Communications rooms are sized to provide the linear wall footage necessary for routing cable, mounting termination blocks, mounting electronics and other equipment. Size should be a minimum of 100 sq. ft. (minimum width 8') and provide a 32" clearance on each side for 19" electronic equipment racks.

C. OTHER SPECIFICATIONS

All other specifications for communications rooms are identical to those listed in Section III.D "**Error! Reference source not found.**" and III.E "**Error! Reference source not found.**" except the following.

1. Door

A single, solid door 3' 0" in width with a 180° hinge shall be provided and mounted to swing outside the room. The door shall be installed either on the right or left side of the room, and not in the middle of a wall.

2. Environment

A minimum of 9,000 BTUs of cooling is required.

V. **INTRA-BUILDING DISTRIBUTION SYSTEM**

In all buildings, horizontal and vertical communications distribution systems are an absolute necessity in meeting and in keeping pace with the building occupants' voice, data, and video communications needs. The distribution systems are designated to house the cables and wiring necessary to connect communications equipment with the control and cross-connecting switching equipment located in the telecommunications entrance room and in each communications room.

As the needs of the University and Health System change and grow, the communications service requirements increase accordingly. Although the initial communications outlets are identified based on furniture layouts, five out of ten outlets are likely to be changed or relocated in some manner each year. The design and capacity of a communications distribution system should have built-in flexibility to anticipate this movement and should be planned for in the initial building design. Therefore, it is prudent to design a building in such a way as to ensure that an adequate and functional intra-building distribution system is provided for communications. The capacity and flexibility of the communications system is determined in consultation with OIT, DHTS and the project manager.

A. HORIZONTAL CABLING SYSTEM

1. Cable Tray

Minimum standards require that the cable tray be 12" wide and 4" deep. The tray shall be open on top and suspended from the ceiling by supporting rods as recommended by the manufacturer. No rod threads should be exposed in the cable tray, to avoid damaging the cable during installation. To deter the use of plenum cable, open wire ways may only be used in air return spaces in very special cases. The cable tray shall have a minimum clearance of 12" on top and 6" on the sides and bottom from all obstructions (for example, sprinkler pipe, HVAC ducts, lights).

A minimum of one 1" conduit shall be used from the cable tray to the user's communications outlet to house communications cabling. Stub conduits one to two inches from the cable tray. See Section V.A.3 "Conduit System" for standard installation requirements.

2. J-Hooks

Minimum standards require that J-hooks are not more than 5' apart and are installed on the walls above the finished ceiling. J-hooks shall be accessible with a minimum clearance of 6" above, below, and on all sides.

3. Conduit System

Conduit systems are designed to protect the communications cabling. The following are installation standards for each type of conduit. The Duke Project Manager must approve the type of conduit through consultation with Duke Engineering and Operations or Duke Facilities Management. The conduit system shall be designed to allow no more than 25 pounds of pulling pressure on cable when installed.

a. Rigid Metallic Conduit

- Conduit shall be industry-standard, heavy wall steel conduit, and shall have a galvanized finish throughout.
- Conduit shall not be less than 1" trade size.
- Make all cuts square.
- Ream out all burrs from end after threading and before mounting in place.
- Utilize factory-manufactured elbows where change in direction is required. No more than two long radius 90° bends or the equivalent are permitted between junction boxes, pull boxes, cabinets, or cable access points. Pull boxes may not be substituted for 90° bends.
- Utilize threaded couplings and make all joints tight. Running threads, split couplings, and thread-less couplings are not acceptable.
- Install metallic bushings at all terminations, both free standing and within boxes, enclosures, and cabinets.

- During installation, cap all runs left unfinished or unattended. Cap all terminations of finished runs until wire and cable are pulled in. Manufactured fittings shall be used for this purpose.
 - All conduit runs between communications outlets and new Communications Rooms shall be on the same floor. When existing Communications Rooms are not on the same level, conduit shall be installed as individual home runs, unless an OIT representative has granted prior approval of some other method.
- b. Electrical Metallic Tubing (EMT)
- Conduit shall be cold rolled steel tubing with zinc coating on the outside and protected on the inside with zinc enamel or equivalent corrosion-resistant coating.
 - Conduit may be installed in dry construction in furred spaces, in partitions other than concrete, solid plaster or exposed work. EMT shall not be installed where it will be subject to severe physical damage or severe corrosive influence, where trade size is larger than 2", or where tubing, elbows, couplings, and fittings would be in concrete or in direct contact with the earth.
 - Couplings shall be in the compression type with all joints made tight.
 - Follow installation practices as specified in Section V.A.3.a "Rigid Metallic Conduit".
- c. PVC Conduit
- PVC conduit is not acceptable in new construction except in poured concrete slabs.
 - Protection against physical damage must be provided before and during the process of pouring.
 - During installation, all runs left unfinished or unattended must be capped. Manufactured fittings shall be used for this purpose.
 - PVC conduit may be installed above ceilings on renovation projects where existing conditions would prohibit the use of electrical metallic tubing. This applies only to non-air plenum spaces.

4. Outlet Boxes

Except as noted, all boxes shall be manufactured from galvanized industry standard gauge sheet steel.

a. Desk Outlet Box

Desk-telephone outlet boxes shall be a minimum of 4 11/16" square, mounted to accommodate a double gang plaster ring for a double gang faceplate. Standard

mounting height shall be 18", centered above the finished floor, or equivalent in height to electrical outlets.

b. Wall Outlet Box

Wall-mounted telephone outlets with no data requirements shall be a minimum of 4 11/16" square, mounted to accommodate a single gang plaster ring for a single gang faceplate. Standard mounting height shall be 54", centered above the finished floor. ADA requirements for public access phones state that the highest operable part that is essential to the basic operation of the telephone must be a maximum of 48" above the finished floor. The bottom leading edge must be mounted 27" or less above the finished floor. Reference the ADA standards for more details.

c. Floor Outlet Box

Rooms that require floor outlets shall be designed by the architect and discussed with the OIT representative to ensure future flexibility for communications wiring. "Trapped conduit" and tombstones are not acceptable.

d. Junction and pull boxes

Internal diameter dimensions of boxes and the maximum number of cables that may be placed in them are dependent upon the actual requirements for any given building. Consult with the OIT representative for specific details.

A metal pull box should be specified if:

- The length is over 98'
- There are more than two 90° bends
- There is a reverse bend in the run

Pull boxes shall be placed in an exposed manner and location. These shall be readily accessible and not in the false ceiling space, unless immediately above a suitable marked, hinged panel.

Condulet or LB fittings are not acceptable in any case.

B. VERTICAL SYSTEM

New multi-level buildings should be designed with communications rooms placed one above the other in a vertical fashion to facilitate vertical distribution systems. Vertical cable risers make for ease of design, construction, and maintenance. Provide a riser with a minimum of four 4" conduits or sleeves to each Communications Room. The total number of conduits or sleeves depends on the number of floors in the building and on the number of tenants/outlets required in the building.

The electrical engineer shall include a single line riser diagram of all conduits as part of the construction documents and drawings. An OIT representative shall approve the conduit sizes and details of this drawing.

VI. HORIZONTAL AND VERTICAL CABLING – VOICE, DATA AND CATV

A. HORIZONTAL CABLING

The horizontal wiring standard is mandatory for all University and Health System renovations and new buildings. This standard also governs all off-campus sites. The standard is structured to meet the majority of telephony and data communications protocols presently used on the Duke campus. The purpose of this standard is to follow industry standards as they evolve and place the entire campus on a standard wiring scheme to increase flexibility for moves and changes within the University and Health System.

The electrical contractor is responsible for pulling all voice, data and video intra-building backbone and horizontal cable as specified in the construction documents. The electrical contractor is responsible for estimating cable footage and pulling cable from the telecommunications entrance room up the riser to each communications room, and throughout the building to each communications outlet.

Apply no more than 25 pounds of pulling pressure on cable when installed.

It is important to note that for every communications outlet location a quad electrical outlet should be co-located. This ensures that adequate power is available for the end user's phone and data equipment.

1. Outlet Cabling

a. Standard Communications Outlet

The standard wiring for University buildings is four Category 6 (CAT 6) cables and one RG-6 coaxial cable pulled to each communications outlet. The CAT 6 cable shall be installed using four different colored cables (blue, yellow, gray, and white) per outlet. Outlets will be noted on the electrical drawings by the symbol ▲. There is no deviation from this standard unless written approval is obtained from OIT. See Figure 1.

b. Wall Outlets

Most wall outlets will contain one CAT 6 cable. Wall outlets will be indicated on the electrical drawings by the symbol ▲W.

ADA requirements may dictate different wall phone heights in special construction circumstances such as wheelchair alcoves, columns, and obstructions. Consult with the OIT representative during the design stage.

2. Voice Cable Specifications

Voice wiring consists of two 4-pair CAT 6 cables (24-gauge) terminating on individual 568B RJ45 jacks (white). Each run shall be continuous with no intermediate terminations. This will support any communications equipment OIT installs.

3. Data Cable Specifications

Data wiring is two 4-pair enhanced CAT 6 cables (24-gauge) terminating on individual 8-position 568B RJ45/Category 5 data jacks (black). Runs shall be continuous with no intermediate terminations. This will support data communications up to 100 megabits, Ethernet, Token Ring, AppleTalk, DHIS, DECNET and modems or line drivers.

4. CATV Cable Specifications

CATV wiring consists of one RG-6 coaxial cable terminating on an "F" connector.

B. VERTICAL CABLING

The vertical wiring standard includes pulling copper, multi-mode fiber, single-mode fiber and 1/2" coaxial cables from the telecommunications entrance room to each communications room in the building. All fiber cable shall be pulled in interduct. Quantities of each type of cable depend on the building's occupants and their requirements for voice, data, and video. The electrical contractor is responsible for pulling all voice, data, and video intra-building backbone and horizontal cable as specified in the construction documents. Again, early consultation with OIT is required so the quantities of cable and raceway systems can be determined.

VII. **WIRELESS INFRASTRUCTURE DESIGN**

Wireless network infrastructure shall be provided in all new buildings and construction projects. Wireless systems must be designed according to plan documents in the schematic design phase. The wireless system design shall require 1" trade size conduit from the raceway system to each wireless node location using a 4 11/16" square box with a double gang plaster ring. Pull three CAT 6 cables to each wireless node.

VIII. **ASSEMBLY ROOMS**

In addition to the standard horizontal wiring scheme, the following communications wiring shall be pulled in University and Health System auditoriums, classrooms, teaching labs, and conference rooms. All wiring will share the 1" conduit connecting the communications outlet to the communications room. See Figure 2.

Pull one coaxial RG-6 in the same standard double-gang box as used in the horizontal wiring scheme. Coaxial cable shall be terminated at the faceplate and the other end shall be coiled in the communications room until needed.

Pull one six-strand multi-mode fiber optic cable. Both ends shall be coiled (25 ft. in communications room and 5 ft. at outlet) and labeled unless the user has immediate need for terminated fiber circuit(s).

IX. RESIDENCE HALL ROOMS

Pull one CAT 6 cable for voice, one CAT 6 cable for data, and one RG-6 coaxial cable for cable television. The outlet box shall be 4 11/16" square with a single gang plaster ring. The conduit shall be a minimum of 1" trade size to the raceway system.

X. PAY TELEPHONES

Run one CAT 6 cable with a minimum of 4' slack at outlet location. OIT will notify Verizon for installation of phone instrument.

XI. PARKING GATES

Parking gates require 1" underground conduit with direct access from the telecommunications entrance room to the gate arm pedestal. Pull two CAT 6 underground rated cables for a mounted gate phone or emergency phone. Also, pull special cable for gate card reader. For wire type and other specific information, contact the Duke Card office at (919) 684-5800.

XII. EMERGENCY TELEPHONE LOCATIONS

Requires 3/4" underground conduit with direct access from the telecommunications entrance room to pole or wall location. Include two CAT 6 cables with minimum 10' slack at outlet location.

XIII. ELEVATOR PHONES

The purchase and installation of the elevator traveling cable is the responsibility of General Contractor. OIT will provide assistance with the installation of the telephone and telephone line.

XIV. EMERGENCY CALL BOX SYSTEM

All telephone instruments located in elevator cabs and emergency stations are connected to an emergency reporting system staffed by Duke University's Police Department located at 502 Oregon Street. This system provides a voice channel and location identification when the handset is lifted off hook.

This type of station is used for the following types of emergencies:

- Vehicle accidents
- Personal assaults

- Fire
- Sick or injured persons
- Suspicious incidents/persons
- Criminal activity
- Personnel assistance

An OIT representative will consult with Duke Police concerning the locations and number of units required. All new emergency call box locations must be configured to ADA specifications. OIT will coordinate the installation of free-standing tower emergency telephones with the Duke High Voltage Department. The electrical contractor is responsible for the installation of conduit and cable only.