

Communication Facilities Construction Design Standards

February 2016



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1 Introduction

Duke University has a multitude of voice, data, audio visual and security 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. These requirements must be met for all on-campus Duke University Facilities.

1.1 Planning and Design

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 communications service provider, Office of Information Technology (OIT). OIT is interested in providing a high quality, consistent infrastructure, and bring expertise to the complex world of communications at Duke.

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.

For ease of coordination, please contact an OIT analyst below. 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.**

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.

For all University buildings, contact either of the following:

Chet Sikes, RCDD
Communications Infrastructure
Design and Engineering, OIT
334 Blackwell St., Suite 2111
Box 104111
Durham, NC 27708-4111
(919) 684-2045
chet.sikes@duke.edu

Dickson Clifford
Field Operations Manager, OIT
334 Blackwell St., Suite 2111
Box 104111
Durham, NC 27708-4111
(919) 613-6697
dickson.clifford@duke.edu

1.2 Responsibilities

OIT is responsible for supplying all voice, data and video backbone and horizontal cable. OIT will hire a telecommunication contractor to pull, terminate, label and test all cable. OIT will provide voice and data equipment and materials to up fit the telecommunications rooms.

The electrical contractor is responsible for the purchase and installation of the approved raceway system.

2 Building Communications Service Entrance

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

2.1 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.

2.1.1 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.

2.1.2 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.

2.1.3 Sealing conduits

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

2.1.4 Bends

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".

2.1.5 Pull strings

Equip every conduit with a nylon line that has a minimum test rating of 200 pounds.

2.2 Building feed cables

Each building must have inter-building copper, and fiber 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.

3 Main Distribution Frame (MDF) Room

The Main Distribution Frame (MDF) room serves as the demarcation point 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 Intermediate Distribution Frame (IDF) room. The MDF contains electronic equipment and can double as the IDF 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 IDF **does not exceed 295 linear feet or 90 linear meters.**

See page 14 diagram T101 for more details on a Typical MDF design.

OIT will design and budget for the cable support system in each MDF and IDF according to minimum standards. These specifications will be included in the bid documents to the telecommunications contractor.

3.1 Location

3.1.1 General

The MDF 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 MDF 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]).

3.1.2 Relation to IDF

Locate the MDF room in such a place as to provide a riser for all other IDF rooms in the building.

3.1.3 Electromagnetic interference

Do not locate the MDF 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).

3.2 Size

The MDF room must be a minimum of 150 sq. ft. (minimum width 10'), which provides a 32" clearance on each side of a loaded 19" equipment rack, on which power outlets are normally mounted. This room size will provide service to approximately 20,000 square feet of building.

3.3 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.

3.3.1 Entrance to the MDF room

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

Conduits entering the MDF 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.

3.3.2 Riser cable

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

- All intra-building backbone cable for voice, data, and video communications between the MDF room and each IDF room.
- All horizontal cable for voice, data, and video communications between the IDF room and each communications outlet.

The telecommunications contractor shall label all cable pulls in the IDF 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 IDF room. Each cable run shall include a minimum of 25' of slack in the communications room and 12" of slack at the communications outlet.

3.3.3 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.

3.4 Electrical requirements

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

3.4.1 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.

3.4.2 Power requirements

When emergency power is available:

Provide one dedicated simplex receptacle NEMA 5-15R 20A/120V to normal power and one dedicated simplex NEMA 5-15R 20A/120V emergency standby power terminated in each vertical wire manager.

When only standard power is available:

Provide one dedicated quad receptacle NEMA5-20R 20A/120V to normal power terminated in each vertical wire manager.

See pages 14 and 15 diagrams T401 and T501 for details on typical rack power options.

3.4.3 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.

3.5 Structure requirements

3.5.1 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.

3.5.2 Floor coverings

To keep dust and static electricity to a minimum in the MDF room, use floor finishes of VCT or cement sealers. **Carpeting is not permitted.**

3.5.3 Walls

The walls of the MDF 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.

3.5.4 Wall covering

All interior wall surfaces shall be lined with pressure-treated, fire-retardant 3/4" plywood. These 4' x 8' plywood panels shall be installed vertical 6" above a finished floor and painted white for light reflection. Anchors for plywood panels shall be sufficient to support all background equipment apparatus.

3.5.5 Ceiling

Ceilings must be at least 12'-0" high to provide adequate space over the equipment frames for cables and suspended racks. False ceilings are not permitted in the MDF room.

3.5.6 Environment

The temperature of the MDF room must be maintained between 64° and 75°F. The relative humidity range must be between 30% and 55%.

A minimum of 20,000 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.

3.5.7 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.

3.5.8 Card readers

Provide a card reader for entry into the MDF.

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.

4 Intermediate Distribution Frame (IDF) Room

IDF 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.

See page 14 diagram T101 for more details on typical IDF design.

4.1 Location

IDF 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 IDF rooms.

4.2 Size

IDF 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. (10' by 10') to provide a 32" clearance on each side of the loaded 19" equipment racks.

4.3 Other specifications

All other specifications for IDF rooms are identical to those listed in sections 3.4 **Electrical requirements** and 3.5 **Structure requirements** except the following.

4.3.1 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.

4.3.2 Environment

A minimum of 10,000 BTUs of cooling is required.

5 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 MDF room and in each IDF room.

As the needs of the University grow, the communications service requirements increase accordingly. Although the initial communications outlets are identified based on furniture layouts, changes with occur 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 and the project manager.

5.1 Horizontal cabling system

5.1.1 Cable tray

Minimum standards require that the cable tray be 12" wide and 4" deep basket tray. The tray shall be 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. 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 5.1.3 Conduit systems for standard installation requirements.

5.1.2 J-hooks

J-hooks are not recommended and the designer must receive approval for use in Duke University Buildings. If approved, the 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.

5.1.3 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 Facilities Management. The conduit system shall be designed to allow no more than 25 pounds of pulling pressure on cable when installed.

5.1.3.1 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 IDF rooms shall be on the same floor. When existing IDF 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.

5.1.3.2 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 5.1.3.1. Rigid metallic conduit.

5.1.3.3 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.

5.1.4 Outlet boxes

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

5.1.4.1 Desk outlet box

Desk-communication outlet boxes 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 18", centered above the finished floor, or equivalent in height to electrical outlets.

5.1.4.2 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.

5.1.4.3 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.

5.1.4.4 *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.

5.2 Vertical system

New multi-level buildings should be designed with IDF 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 IDF 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 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.

6 Horizontal and Vertical Cabling – Voice, Data, AV and Security

6.1 Horizontal cabling

The horizontal wiring standard is mandatory for all University renovations and new buildings. 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.

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

6.1.1 Outlet cabling

6.1.1.1 Standard communications outlet

The standard wiring for University buildings is two Category 6a (CAT 6a) cables pulled to each communications outlet. The CAT 6a cable shall be installed using two different colored cables (blue 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.

6.1.1.2 Wall outlets

Most wall outlets will contain one CAT 6a 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.

6.1.2 Cable specifications

Voice and data wiring are four 4-pair (UTP) enhanced CAT 6a cables (24-gauge) terminating on individual 8-position 568B RJ45/Category 6a data jacks (black). Runs shall be continuous with no intermediate terminations. This will support all voice, data and video communications equipment supported by OIT.

6.2 Vertical cabling

The vertical wiring standard includes pulling copper, multi-mode fiber, single-mode fiber cables from the MDF room to each IDF room in the building. All fiber cable shall be pulled in innerduct. Quantities of each type of cable depend on the building's occupants and their requirements for voice, data, and video. **The telecommunications 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.**

7 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. WiFi-802.11 a/b/g/n coverage across 95%, -67dbmv minimum specification. Estimates for AP coverage to be supplied with construction documents and known building materials. 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 single gang plaster ring. Pull two CAT 6a cables to each wireless node.

8 Cellular Infrastructure Design

Cellular- CDMA/GSM and associated voice/data standards to be enabled across 95% of the area 95% of time, indoors and outdoors. Coverage signal strength to be -92dbmv. Assumptions that building skins will not be permeable to RF signals, therefore all budgets will be prepared as having to provide total coverage.

9 Collaborative Teaching and Learning Spaces

Pull two CAT 6a and one multi-mode duplex fiber cables for voice and data services. The outlet box shall be 4 11/16" square with a double gang plaster ring. The conduit shall be a minimum of 1" trade size to the raceway system.

10 Parking Gates

Parking gates require 1" underground conduit with direct access from the telecommunications entrance room to the gate arm pedestal. Pull two CAT 6a 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.

11 Help Telephone Locations

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

12 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 line.

13 Help Phones Call Box Systems

All telephone instruments located in elevator cabs and help 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 station is used for the following:

- 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 help call box locations must be configured to ADA specifications. OIT will coordinate the installation of free-standing tower help telephones with the Duke High Voltage Department. The electrical contractor is responsible for the installation of conduit and cable only.

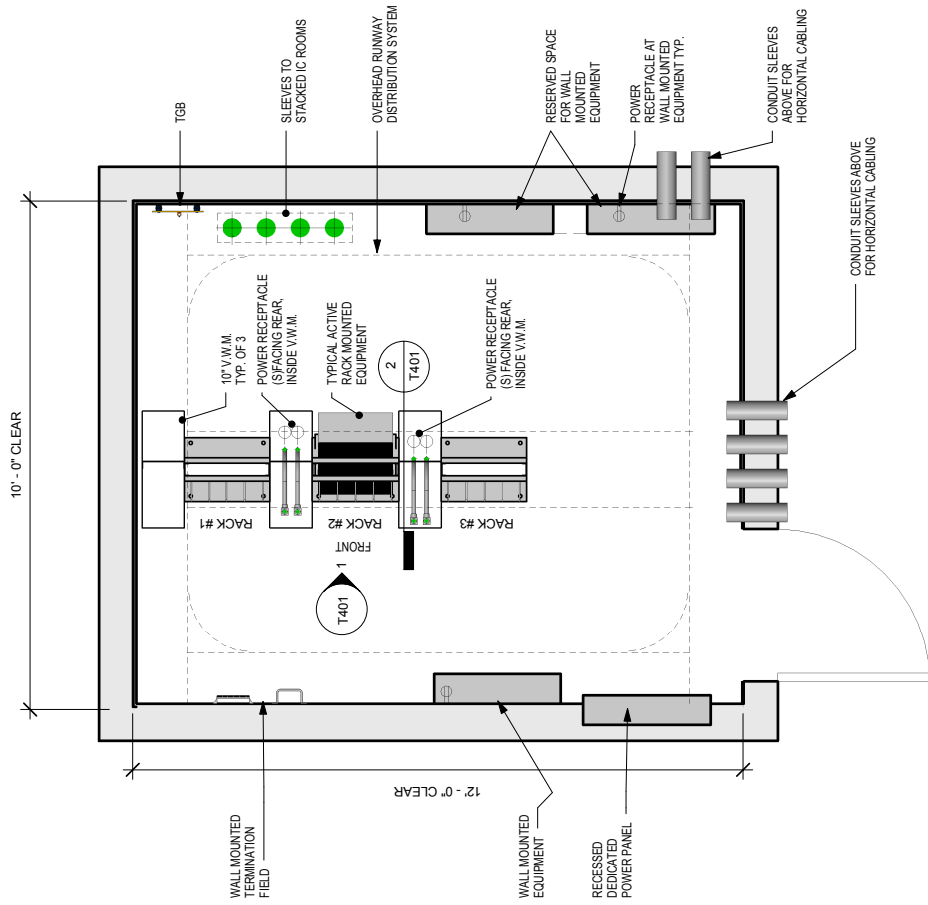
BRVA
 Bert, Rao + Advisors
 Consulting Engineers, LLC
 10 Court St., 4th floor
 Boston, MA 02135
 Tel: 617.254.0016
 Fax: 617.254.9339
 www.brva.com

PROJECT: DUKE UNIVERSITY
 OIT TELECOMM. ROOM REQUIREMENTS
 DESCRIPTION: TYPICAL TR LAYOUT

JOB NO.: 1
 CHECKED: RMT
 DRAWN: JRW
 DATE: 02/18/2016
 SCALE: 1/2" = 1'-0"
 SKETCH:

T101

REV: DWG



TYPICAL IC ROOM - EMERG./STANDBY
 POWER

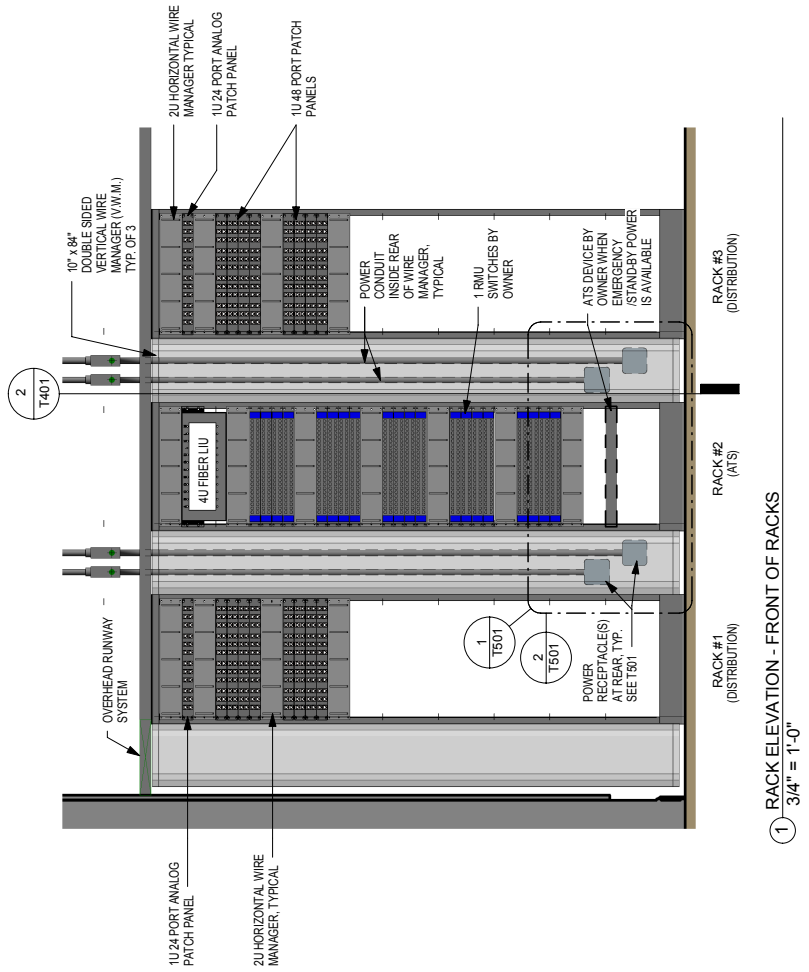
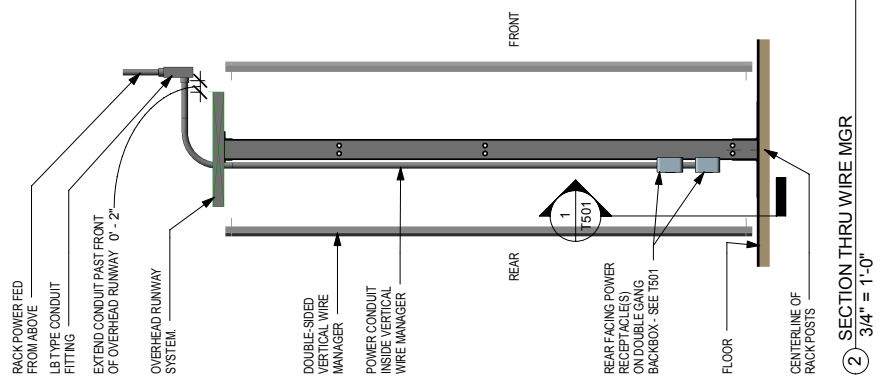
1 1/2" = 1'-0"

BR/RA
 Consulting Engineers, LLC
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 Boston, MA 02135
 Tel: 617.254.4810
 Fax: 617.254.9339
 www.br/ra.com

DUKE UNIVERSITY
 OIT TELECOMM. ROOM REQUIREMENTS

PROJECT: _____
 DESCRIPTION: _____
 JOB NO.: _____
 CHECKED: RMT
 DRAWN: JRW
 DATE: 02/18/16
 SCALE: 3/4" = 1'-0"
 SHEET: T401

REV. DWG



Brd. Rao + Associates
 Consulting Engineers, LLC
 10 Court St., 4th floor
 Boston, MA 02135
 Tel: 617.254.0016
 Fax: 617.924.9339
 www.brba.com

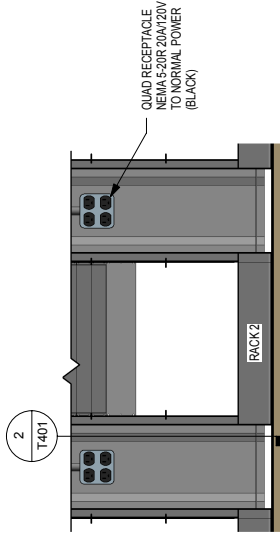


PROJECT: DUKE UNIVERSITY
 OIT TELECOMM. ROOM REQUIREMENTS
 DESCRIPTION: TYPICAL TR RACK POWER RECEPTACLE OPTIONS

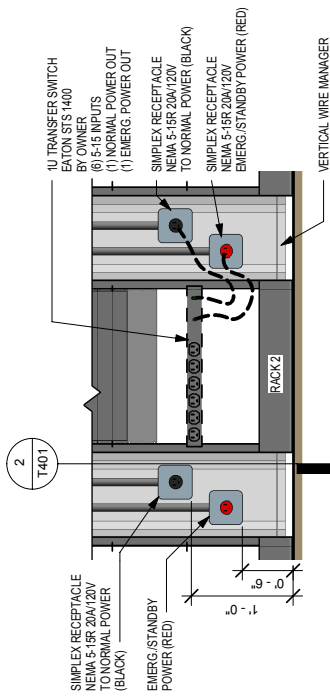
JOB NO.:	1
CHECKED:	RMT
DRAWN:	JRW
DATE:	02/18/16
SCALE:	1" = 1'-0"
SKETCH:	

T501

REV. DWG



POWER RECEPTACLES REAR OF RACKS
 ② - EMERGENCY POWER NOT AVAILABLE
 1" = 1'-0"



POWER RECEPTACLES REAR OF RACKS
 ① - EMERGENCY POWER AVAILABLE
 1" = 1'-0"