THE OHIO STATE UNIVERSITY COMMUNICATIONS WIRING STANDARD

The objective of the standard wiring plan for the University is to provide an acceptable outlet for any communication device that requires connection to other devices, networks, or information services serving general University needs. The establishment of a standard wiring plan will support most communication devices and provide a standard by which buildings should be wired. Renovations and network upgrades should be developed following this standard to provide a uniform connectivity guideline for the whole campus community.

The purpose of this document is to provide guidelines by which the communications needs of the University can be met. These guidelines are to be used as a means to provide minimum requirements. Specific requirements for each project will be coordinated with the using agency and an OCIO Telecommunications and Networking representative during project development.
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SECTION I

Guidelines for Communication Outlets

GENERAL

Guidelines concerning the number of communication outlets by room type are outlined below. Specific requirements for each room and each project shall be coordinated with the using agency at the onset of design for renovation and new construction projects and prior to the initiation of work orders, contracts, or other installation action for other types of projects. The architect/engineer for major renovation and new construction projects should be aware that the Program of Requirements might not be all-inclusive regarding communication facilities. Therefore, the project architect/engineer must work very closely with the appropriate using agency, Academic Technologies Service, Classroom Support, and an OCIO Telecommunications and Networking representative during initial planning to ensure total coordination and minimize the need for revisions during the design development phase. Sections IV and V also contain data of concern to the project architect/engineer. This guideline is limited to minimal standards for the wiring and wiring path only. Ancillary devices such as (but not limited to) phones, modems, ethernet hubs, baluns, and electronic devices are the responsibility of the user.

TERMINATIONS

1. Faculty/Administrative Offices, Clerical/Staff Offices, Secretary/Administrative Assistant Offices

Two duplex communications outlets (jacks) for offices with fixed walls of 75 square feet or more are required. One additional duplex outlet for each additional 75 square feet of office space or each additional occupant is required. For offices designed with modular furniture each cubicle or workstation will be provided with one duplex communication outlet per designated occupant. Additionally, a set of station wires (one voice and one data) will be installed as spare to each cluster of 6 office cubicles.

2. Classrooms/Lecture Halls/Auditoriums

In Classrooms, Lecture Halls and Auditoriums four communication outlets (one on each wall) are required. The need for a cable TV outlet will be considered during the planning process. The cable TV outlet is not intended to solve all audio/video needs in Classrooms Lecture Halls and Auditoriums. Specialized audio/video needs should be coordinated on a per project basis with Academic Technologies Service, Classroom Support. Classrooms may be designed to be subdivided, by adding or removing walls, in the future. If this is a design consideration, the number and location of communication outlets will be adjusted accordingly.

The recommended location for outlets is as follows:
1) Chalkboard area
2) Projection booth/rear wall
3) Lectern area
4) Remaining sides

3. Laboratories

One single wall phone outlet and one duplex communication outlet.

4. Graduate Student Offices

One duplex communication outlet for every 75 square feet of space. Above 200 square feet one duplex communication outlet on each wall is required.

5. Residence Halls

One voice jack for RA and hallways, one data jack per student, and one cable TV (or IPTV) outlet in each room.

6. Patient Care Rooms

One duplex communication and one cable TV (or IPTV) outlet for each occupant.
7. Conference Rooms

One duplex communication and one cable TV outlet in each room. Rooms with more than 500 square feet should have two duplex communication outlets.

8. Storage Areas

One wall-phone communication outlet for each room over 500 square feet and one additional outlet for each additional 2000 square feet are required.

9. Libraries

Libraries will be wired in accordance with the size of the room and need for communication. A minimum of 1 duplex communication outlet is recommended for each room no matter what the use of the room.
SECTION II

CABLE AND WIRE FACILITIES (see exhibits A-E)

GENERAL

1. Cable facilities (conduit, cable trays, raceways etc.) are required for connecting laboratory, classroom, and office pod areas with building communications equipment rooms (IDFs and MDFs). Cable facilities are furnished by project funding.

2. OCIO should be consulted before removal of telephone wire and equipment, i.e., when office partitions are relocated. All wiring must be removed all the way back to the source.

3. All communication outlets will have conduit, Wiremold, or other suitable path provided to the nearest IDF/MDF or to a cable tray that provides a path back to the nearest IDF/MDF.

4. The electrical contractor will provide a pull string in all empty conduits.

5. All work specified shall be UL listed and in accordance with the most current versions of the following codes and agencies:
   
   A. The National Electrical Code, Article 800
   B. National Fire Alarm and Signaling Code (N.F.P.A. 72)
   D. National Electronic Manufacturer’s Association (NEMA)
   E. Institute of Electronic and Electrical Engineers (IEEE)
   F. EIA/TIA 568, Commercial Building Telecommunications Wiring Standard which includes EIA/TIA 568A, 569, 607, and TSB 75.

Electrical Facility Relationships

Although the electrical load is minimal (most devices draw less than 1 amp), every component requires electrical service: modems, terminals, printer, etc. Each communication outlet should be in proximity to a duplex electric outlet in addition to present design requirements to accommodate the need to “plug in” electronic equipment. The Architect/Engineer shall work with the using agency to determine the power requirements of electronic equipment and to provide dedicated circuits where required.

BUILDING CONDUIT AND CABLE TRAY SYSTEMS

1. Conduits to communication outlets are to be a minimum of one inch. A dedicated conduit will serve each outlet box. All conduit “stubs” must have conduit grounding bushings on the ends and be properly grounded. Pull boxes, if needed, must be accessible. Do not place pull boxes above fixed ceilings, HVAC ducts or piping.

2. No conduit run, without a pull box, is to be longer than 100 feet and no more than two 90-degree bends. No conduit run shall accumulate more than a total of 180 degrees in bends. No conduit Body LB style may be used in lieu of pull boxes for communications. Conduits at time of Life Safety Inspection will be no more than 40% full. See D rating chart. (see Exhibit E).

3. Communication outlet boxes will be H-4 11/16” X W-4 11/16” X D-2 1/8”, equipped with a 2-gang cover/plaster ring. Wall-phone outlets will be equipped with a single-gang cover/plaster ring. The height of these boxes will be determined by the use of the box, keeping in mind that wheelchair access heights vary from project to project and close contact with OCIO will eliminate moving the box.

4. A cable wire tray may be placed above drop ceilings with the 1-inch communication outlet conduits stubbed to the cable tray from individual room outlets. This tray will provide a path back to the IDF or MDF. The tray will have a maximum of 8-inch spacing between cable supports and 4-inch sides. Width of the tray will be determined by the quantity of cables in the tray, and projected growth. Cable Trays and conduits must be properly grounded. All NEC codes for grounding of cable trays will be adhered to. Basket Tray is now acceptable, as long as, it has 4 inch sides.
5. Access to the IDF or MDF is acceptable by either extending the cable tray or providing conduit.

6. A path from the MDF to IDF(s) and IDF to IDF is required. Cable tray, conduit(s), or sleeved holes (which must be grounded at both ends) that provide this path are acceptable. The volume of cable and predicted expansion determines the size and quantity of the units that make up the path. (See Exhibit A)

7. Approved UL fire stop must be used when penetrating fire rated walls or floors. If conduits are to be fire stopped pliable putty must be used. Several fire stop materials are available as putty. Most have intumescent properties.

These types of putty:
A. Have the consistency of glazing putty.
B. Remain permanently soft and pliable.
C. Allow easy fire stop reentry.
D. May be installed in conjunction with ceramic fiber, mineral wool filler, or other approved fill material as required.
E. Hilti CP 618 is strongly recommended or OCIO approved equal.

EXAMINATION
1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements.
2. Prepare wall penetrations and verify that penetrations of rated walls are made using products labeled for type of wall penetrated.
3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual type and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

ELEVATOR PHONES: The following are the procedures for elevator phones.
1. It should be written into the contract documents that the Electrical Contractor is responsible for the installation costs of the elevator phone line(s).
2. The Electrical Contractor shall send OCIO a letter requesting service be activated to the specific elevator equipment room(s). Indicating the date of service is also required. NOTE: Normal installation time for OCIO is 5 working days from the date of receipt of the request.
3. Facilities Operation and Development shall send OCIO a requisition form E-Request requesting that monthly service fees for the elevator phone lines at the specific location be charged to them on the account number provided.
4. The FOD Design and Construction Project Manager will solicit the above documents from the Electrical Contractor and Facilities Operation and Development, attach them together and forward them to OCIO.
5. See Exhibit R for equipment room layout.
SECTION III

MAIN AND INTERMEDIATE DISTRIBUTION FRAMES

GENERAL

OCIO personnel should be consulted during the planning stages of any building construction or building renovation. In some cases, existing MDFs and IDFs may have to be enlarged to accommodate changes in the use of building space. In such cases the project will pay for the enlargement of the facilities.

MAIN DISTRIBUTION FRAME (See Exhibit F)

1. Space for connection of the building communication cable to the outside plant should be provided in a separate room and not shared with other utility services, particularly the electrical service. When possible, this room will not be adjacent to the electrical distribution room.

2. Room size will be determined by the size and use of the building. Room size should be large enough to mount electronic equipment to support Local Area Networks (LANs) such as relay racks, hubs, multiport repeaters, or paging. For major renovations and new building projects, a size may or may not be included in the Project Program of Requirements. In either event the project Architect/Engineer must, during the initial (Schematic, Preliminary) planning stage, engage the coordinated efforts of OCIO Telecommunication and Networking, Office of Facilities Planning and Development, and the using agency to ensure appropriate size and arrangement of the communications equipment room(s). These room(s) will need to be environmentally controlled to insure proper reliability of sensitive electronic equipment.

3. Backboards for MDFs and IDFs are to be 3/4"x48"x96" type APA A-D Group 1 plywood, fire retardant treated, with the A side facing the room. All usable walls of MDF/IDF’s will have backboards.

4. At all MDF locations a double duplex electric outlet will be provided on a dedicated circuit, placement of these circuits shall be discussed during the design phase. A 48-inch double tube fluorescent light should be placed above the MDF/IDF panel. Incandescent lights may be used as long as 50 foot- candle lighting can be obtained at the MDF/IDF panel.

5. A "ring run" will be provided at all MDFs to keep jumper (crosscut) wire organized. This will be accomplished by the use of 4-inch wide aluminum "D" rings screw-mounted above the top of the 66 blocks. The bottom of the "D" ring will be mounted two inches above and centered over the space between each vertical row of blocks. "D" rings should be open or split to allow placement of crosscut wire.

DATA CONNECTIVITY

1. Data connectivity shall be on 19 inch racks which will be located either in a communication closet or a designated area set aside for network systems equipment. Such as, but not limited to, routers, hubs, switches, fiber terminations, patch panels, and shelves. (see Exhibit M).

2. Open style data racks shall be 19 inches wide, 84 inches high, and shall meet EIA standards. Racks shall be listed to the UL 1863 Standard for Communication Circuit Accessory. Hubbell CS1976 are strongly recommended for university data connectivity. Under no circumstances shall flush mounted or surface mounted phone panels be used for data connectivity.

3. Any racks that are floor mounted will be provided with tip bars and all additional accessories as required for a complete functional system. Both vertical and horizontal cable management systems must be provided on all relay racks. There must be enough space in the MDF/IDFs to accommodate 31-inch isle-ways. All racks must be grounded to the building ground or bonded to the cable tray system.

4. Provide a multi-outlet AC plug strip. Provide enough outlets to accommodate all electronic devices in the relay rack. The strips shall be mounted on standoff brackets so as to provide 6 inches of separation from the cable.
management system. Strips shall be mounted on the rear of the rack. If UPS systems are being used AC power must be evenly distributed between UPS and other source of AC power.

5. Patch panels for relay racks shall be sized to accommodate current project requirements plus 30% growth capacity. Patch panels shall not exceed 4 x 48 port (maximum total of 192 connections) in a relay rack. Recommended Hubbell UDX48E or OCIO approved equal.

6. Enclosed cabinets shall have a rack mount width of 19 inches and an overall height of at least 76 inches. Enclosed cabinets shall have a roof mounted cable fan and cable entry, enclosed cabinets must be at least 32 inches deep to accommodate a rack mounted UPS. Enclosed cabinets shall be firmly secured as to be unmovable. Recommended enclosed cabinet is Rittal Universal PS Networking Cabinet # 9968086.

7. Wall mounted racks shall be 19 inches in width and 48 inches in height. All wall mounted racks will be mounted on ¾ inch” type APA A-D Group 1 plywood, fire retardant treated, with the A side facing the room. (see Exhibit S for Netshelter requirements).

**INTERMEDIATE DISTRIBUTION FRAMES (See Exhibit G)**

1. IDFs will be a secure room, closet, or space directly accessible from a hallway, public access space, or within a mechanical room. Janitor’s closets and electrical closets are not acceptable as IDF spaces. A duplex electric outlet will be **provided on a dedicated circuit**. A 48-inch double tube fluorescent light should be placed above the IDF panel. Incandescent lights may be used as long as 50 foot candle lighting can be obtained at the IDF panel.

2. In large buildings, more than one IDF per floor may be required. A large building is defined as any building in which the physical layout of a floor would require cable “runs” (IDF/MDF to outlet) in excess of 300 feet (90 meters).

**GROUNDING**

A #6 insulated wire will be provided from the building service entrance ground to all MDFs and IDFs terminated on a ground bar. All equipment, cable tray, ladder rack, relay racks, conduits, and conduit sleeves, will have the same ground as MDF/IDFs. The DC resistance from the MDF/IDF to the building earth ground shall not exceed 0.5 ohms on the longest run. (see Exhibit Q).

**SECURITY**

Access to all rooms or closets containing voice or data equipment will be through one uniform key system. Facilities Operation and Development has established the NET keys are to be used. All new buildings after 2012 should have card access to MDF/IDF’s for security. Any card access to communications closets must include OCIO personnel.
SECTION IV

CABLE, WIRE and OUTLET INSTALLATION

COMMUNICATION OUTLETS (SEE Exhibit L)

A statement shall be included in all specifications on renovation and construction projects, to read as follows;
Cable, wire, and outlet installation shall be performed by personnel that have been certified by an organization
such as BICSI (Building Industry Consulting Service International) or have at least 5 years’ experience in the
telecommunication industry.

1. Minimum Requirements for communication outlets, except wall phone outlets, will be duplex, ivory for phone
and black for data, flush mount. Jack mounting plates will be designed for installation of interchangeable
modules, manufactured by Hubbell, Leviton, or OCIO approved equal. Floor mounted outlets will be coordinated
with the architect, user, and OCIO during the planning stages of each project. Approval of any outlets (jacks) on
shop drawings must be handled through the FOD Design & Construction Project Manager and OCIO.

2. The top opening of the faceplate mounting will be equipped with an eight (8) pin ivory module, manufactured
by Hubbell (catalog # HXJ6TI), Leviton, or OCIO approved equal. The opening in the module will accommodate
a standard male telephone plug.

3. The bottom opening of the faceplate mounting will be equipped with an 8 pin, Category 6, black module,
manufactured by Hubbell (catalog # HXJ6BK), Leviton, or OCIO approved equal. The 8 pins will be wired in
accordance with ISDN, T568A standard.

4. The faceplate will be stainless steel or plastic in accordance with architectural design (Hubbell IFP26TI). The
faceplate shall have four or six modular openings designed to accommodate the jacks listed above. Openings
without jacks installed, will have blank inserts installed (Hubbell SFBI10). Stainless steel covers (Hubbell
SSF206) should be used in auditoriums and classrooms, where frequent use or abuse is more likely.

5. Wall phone outlets will be plastic, ivory, 6-conductor, and designed for modular mounting of wall phones.
Suttle SE 630AC6 44. The highest operable part of the telephone shall be 54”.

6. Any configurations beyond this minimum standard will be handled on a per project basis.

WIRELESS OPTIONS FY15 (see Exhibit K)
There are 3 options for installing Wireless Access Points (WAPs) from the OCIO. All options include
the following:

- Survey of space (virtual or site depending on project) & identify AP locations
- Estimate development depending on which option is chosen
- OCIO purchases WAPs & Ethernet switches
- Certification upon completion of installation.
- See Exhibit “K” of the OSU Wiring Standard for installation guidelines.
- For pricing model please contact 614-688-4357 (8-HELP on Campus) and ask for a
  Relationship Manager.

Option A :
OCIO complete install
  - Installation of WAPs including cabling and basic pathway by the OCIO
  - If additional pathway is needed it will be included in the estimate to the customer
  - Full price/no credits

Option B:
Project supplies pathway and cable with terminations, OCIO installs WAPs
Installation of pathway and cabling by project for WAPs
Project is responsible for all terminations and testing
OCIO will inspect installation and witness testing of cabling
Prior to placement of WAPs a mock-up will be provided for OCIO approval.
OCIO will install WAPs upon completion of testing
With this option there will be a credit given for each WAP since the project installed the pathway/cabling
Removal and storage of WAPs will be done by the OCIO on renovation projects. Project Managers are to notify the OCIO when WAPs can be removed.

Option C:
Project is responsible for pathway/cabling/terminations/WAP installation
Installation of pathway and cabling by project for WAPs
Project is responsible for all terminations and testing
OCIO will inspect installation and witness testing of cabling
Prior to placement of WAPs a mock-up will be provided for OCIO approval.
OCIO provides WAPs for the project to install.
Project is responsible for placement of WAPs after inspection and testing is complete
With this option there will be a credit given for each WAP since the project installed the pathway/cabling and WAP
Removal and storage of WAPs will be done by the OCIO on renovation projects. Project Managers are to notify the OCIO when WAPs can be removed.

STATION WIRE

1. Each communication faceplate will be wired with a minimum of two 4-pair unshielded (Category 6) station wires. Each wall phone outlet will be wired with one 4 pair unshielded (Category 6) station wire. All station wire will be 24-gauge, twisted, solid annealed copper conductor, individually insulated with high density color-coded PVC. All communication wire and cable installed in a building must meet the requirements of ARTICLE 800 of the National Electrical Code. Splicing in station wire is not permitted; wire must be continuous from IDF or MDF to the outlet (jack). (I.e. extending of communications and/or data outlets is not permitted). Wireless access points will be a Category 6 station wire. (see Exhibit K).
A. Any cabling that is kinked, stretched, punctured, ripped, or twisted will be removed and reinstalled at contractors cost.
B. No low voltage cabling will touch ceiling tile, ceiling grids, conduits, walls, or any other structure. Cable will only rest in the pathway that it was designed to be installed in.

2. One of the 4 pair (Category 6) station wires will be terminated on the top module of the faceplate in accordance with the color-coding on the module, and punched down on the blocks at the IDF/MDF.

3. One of the 4 pair (Category 6) station wires will be terminated on the bottom module of the faceplate in accordance with the color coding on the module. CAUTION: Very close attention must be paid in maintaining the twist of the pairs at both ends of the cable! The twist must be within 1/2 inch of any termination.

4. Each communication faceplate will be numbered as follows with a 4-digit number: Each faceplate must have numbers for every outlet on that faceplate. The first digit of the number will be the floor. That is, 0 will be used for ground floor or basement, 1 will be the first floor, and 2 will be the second floor, continuing through the appropriate number. The next three digits will be sequential numbers starting with 001 if there is only one IDF on a floor. If the building has more than one IDF on a floor, each IDF will have a block of 250 numbers assigned to it. That is, 001 through 250 for IDF number 1, 251 through 500 for IDF number 2, and so on, as required.
5. The numbering of the blocks in the MDF or IDF’s must be sequential numbers starting at the top left of the block and continuing straight down the block or row of blocks. All voice jacks will have odd numbers only, example (001, 003, 005, etc.) All data jacks will have even numbers only example (002, 004, 006, etc.) In MDF/IDF locations on renovation projects where the numbering is already established check with OCIO on the next sequential number to be used.

6. After each communication outlet is wired and the IDF is punched down, every conductor must be checked for shorts, crosses, reversals, and continuity. Cat 6 data jacks should also be checked for attenuation, capacitance, impedance, resistance, near-end cross talk, cable length, ELFEXT, return loss delay, delay skew, and ambient noise. Tests shall follow TIA-568-C specifications and be witnessed by a Representative of OCIO and shall be monitored by a recorder where appropriate. Fluke Networks DSX 5000 or OCIO approved equal. Provide a hard copy of test results to OCIO, or a disk with the test results in Microsoft word format.

COLOR CODES:

Pair 1 - White Blue, Blue White
Pair 2 - White Orange, Orange White
Pair 3 - White Green, Green White
Pair 4 - White Brown, Brown White

MDF/IDF; Beginning in July of 2010 all new buildings with no existing MDF/IDF will be utilizing 110 wiring blocks instead of 66 blocks (See Exhibits O & P). Terminations will be on 110 style blocks with a 300 pair base.

1) Shall utilize Industry normal footprint.
2) Must have labeling areas on front and label kits.
4) 110 style IDC termination system.
5) All blocks will be mounted on stand-off legs.
6) Enough connecting blocks must be provided to match all pairs of wiring block.
7) Ortronics OR-110ABC6300 for station cables or OCIO approved equal.
8) Hubbell 110 BLK 300 FTK5 for Riser cables or OCIO approved equal.
9) All feeder cables and station cables will be fed from as far left as possible on the wall and from across the bottom of the plywood and up through the bottom of the blocks.

IDFs (See Exhibit G)

1. At the IDF, 66M150 type blocks are to be used with an 89B standoff bracket for the riser cable and the telephone station wire. Separate blocks or rows of blocks will be used for riser cables and for telephone wire terminations. Relay racks may be used for 4 pair Data cable terminations. Riser cable blocks will be mounted to the left, station wire blocks will be mounted to the right at the IDF. The 4 pair Data cabling may be mounted on relay racks. Patch panels are to have 48 ports, and use a standard 8 pin module for data cabling. CAUTION: Very close attention must be paid in maintaining the twist of the pairs on patch panels. The twist must be within 1/2 inch of the termination.
2. Terminate the riser cable following the standard telephony color code (see Exhibit H) using the first row of pins on the left and the last row of pins on the right of the block. The riser cable will be fed up through the bottom of the 66 block standoff brackets. CAUTION: Very close attention must be paid in maintaining the twist of the pairs in all riser cables. The twist must be within 1/2 inch of the termination.
3. The 4 pair station wire will be punched down using the first row of pins on the left and the last row of pins on the right of the 66M150 blocks and identified by a jack number. Station wire will be fed through the bottom of the 66 block standoff brackets. CAUTION: Very close attention must be paid in maintaining the twist of the pairs in all station cables. The twist must be within 1/2 inch of any termination.
4. The size of the IDF will determine how the 66 blocks and exhibit are to be arranged. The 66 blocks are to be stacked no more than four blocks high with a 2-inch space between the rows of blocks. The Relay Racks are to be arranged to allow at least 31 inches of clearance on three sides of the rack.

MDF (See Exhibit F)
1. All punch down blocks are to start from left to right. Space is to be reserved at the far left for the underground cable and the protectors to be mounted and terminated. The underground cable and protectors will be installed and punched down by OCIO Telecommunication and Networking.

2. The riser cables’ 66M150 blocks will be stacked no more than four high. The top of the 66M150 blocks are to be no more than 72 inches from the floor and the bottom of the lowest block shall be no lower than 30 inches from the floor.

3. All cables and station wire will be fed from the bottom of the 66M150 blocks through the 89B brackets and terminated. The standard telephony color code is to be followed.

4. The first row of riser cable blocks would be the ground floor or basement IDF riser cable. The next row would be the first floor riser cable, and so on throughout the building.

5. If station wires are installed at the MDF, they will be terminated on 66M150 blocks, to the right side of the riser cables. The 4 pair station wire for telephones will be terminated immediately to the right of the riser cable.

6 All the blocks are to be mounted with a 2-inch space between each row. This allows room for crosscuts to be run.

**RISER CABLE (EXHIBIT I)**

1. Riser cables will be 24 gauge, Category 3, twisted solid annealed copper conductors, individually insulated and color coded in accordance with telephone industry standards. Cables having more than 25 pairs will be assembled in individual color-coded binders. All communications wire or cable installed in a building must meet requirements of Article 800 of the National Electrical Code.

2. The riser cable will be sized by the number of communication outlets plus 30%, rounding off the riser cable to the nearest standard size. Minimum size is 100 pairs.

3. In addition to the multi-pair copper riser cables, a minimum of 1 six strand multi-mode, 1 six strand single mode fiber cable (riser rated) or plenum rated when necessary, and one Category 6 unshielded twisted pair cable for each 23 data cables (never to exceed 100 meters), will be run from the MDF to each IDF. The path for these cables will be directly from the MDF to each IDF. Both the fiber and the data cables will be terminated in relay racks.

**SPLICING DEVICES**

During renovation projects where an MDF or IDF is being created or relocated splicing the riser cables shall be reviewed by OCIO. Upon approval splicing may be permitted in the copper riser cables only. Modular splicing devices that are to be used must also be approved.

**SPlice CASES**

An approved cover for splices in a riser system must be used where any two or more cables are spliced together.

**Punch Down Blocks**

66M150 type blocks are to be used with an 89 B standoff brackets at both MDF and IDFs to terminate the riser cables and the station wires. Starting in July of 2010 110 blocks will be utilized on all new buildings. The only 110 blocks authorized for use is Ortronics OR110ABC6300 for station cables and Hubbell 110 BLK 300 FTK 5 for Riser cables or OCIO approved equal

**CATV- Cable TV Overview**

Office of the CIO will have first opportunity to design the cable TV distribution. If it’s agreed upon that the contractor will provide the cable TV design, Office of the CIO will have the opportunity to review and approve the contractor’s design.
Contractor will only use hardware that’s been provided in the OCIO approved materials list for CATV. If the contractor desires to use hardware other than what’s been identified as approved, said contractor will be required to submit samples of the alternate hardware and why the alternate hardware is being requested.

Contractor will be required to place CATV cable drops and hardline distribution to Office of the CIO standards. If Office of the CIO is requested to install any/all wiring it will be at standard Office of the CIO hourly rates and will be billed to the construction project.

Office of the CIO will have first opportunity to perform splicing, activation, testing and documentation of building distribution and CATV cable drop wiring. This will ensure that those aspects are completed to Office of the CIO standards. Assigned contractor shall subcontract OCIO for design, splicing and terminations.

Should Office of the CIO find damaged CATV cable drops and/or hardline coax, Office of the CIO will notify the contractor. Contractor will have first opportunity to replace damaged coax at contractor’s expense. Should contractor not be able to replace damaged coax in a timely manner, Office of the CIO will have the coax replaced and bill the construction project.

**CABLE TV. CABLING**

1. All cable TV. runs will be routed directly from the IDF to the outlet. Splitters and Amplifiers will be mounted at the IDF.

2. The connectors will be a “F” type. Compression type fittings are the only acceptable “F” connectors to be used. **CAUTION:** Proper tools must be used to install the “F” connectors to insure the proper fit and also to insure there is no RF signal leakage. OCIO recommends the Ripley Cablematic C.A.T “All Series” Compression Assembly Tool. The CATV outlet shall be a 75 ohm female “F” to female “F” wall plate adaptor or be IPTV type.

3. For runs of less than 200 feet, drop cable shall be 6 Series quad-shield 75 ohm coaxial cable. The core shall be 18-gauge copper covered steel center conductor with a gas expanded polyethylene dielectric. The shield shall be aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric, a 60% braid of 34 AWG bare aluminum wire, an aluminum-polypropylene-aluminum laminated tape, and a 42% braid of 34 AWG bare aluminum wire. The jacket shall be made of flame retardant polyvinyl chloride. The Series 6 drop cable shall be Commscope #5781 (Plenum #2227V) or OCIO approved equivalent. The connector for the Series 6 drop cable shall be Gilbert #GF-URS-6 (Plenum GF UR 6 PL) or OCIO approved equal.

4. For runs of 201-350 feet in length drop cable shall be 11 Series quad-shield 75 ohm coaxial cable. Any run exceeding 350 feet in length, OCIO must be contacted for technical consultation. The core shall be 14-gauge copper covered steel center conductor with a gas expanded polyethylene dielectric. The shield shall be aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric, a 60% braid of 34 AWG bare aluminum wire, an aluminum-polypropylene-aluminum laminated tape, and a 40% braid of 34 AWG bare aluminum wire. The jacket shall be made of flame retardant polyvinyl chloride. The Series 11 drop cable shall be Commscope #5940 (Plenum #2287K) or OCIO approved equivalent. The connector for the Series 11 drop cable shall be Gilbert #GAF-URS-11-MH (Plenum GAF-UR-11 PL) or OCIO approved equal.

5. Riser cable for RF distribution shall be 0.500” aluminum sheathed 75 ohm distribution cable. The core shall have a fully bonded copper clad center conductor with a high compression, micro cellular foam dielectric. The outer tube shall be solid aluminum. The riser cable shall be Commscope #P3 500 CA or OCIO approved equivalent. The connector shall be GRS-500-CH-DU-03-T or OCIO approved equal.

**FIBER OPTIC RISER CABLE**

Each IDF will have at least 6 strands of armored (all dielectric) 50 micron laser optimized cable (OM3) terminated with fusion spliced LC style pigtails and 6 strands of armored (all dielectric) singlemode cable terminated with pre-terminated SC/APC pigtails placed to the building MDF. All singlemode cable will be fusion
spliced (or ordered factory preterm). No field connectors will be allowed, nor any mechanical splicing of singlemode tails. All terminations will be housed in fiber optic patch panels in the rack. There will be a 20’ service loop at each TR. The 20’ service loop will be placed on the wall using Leviton 49800-0FR for slack management (see Exhibit A) in a craftsmanship like manner. Slack inside the fiber housings does not count towards the 20’ service loop. All cable, hardware, and connectors will be of one manufacturer. There will be at a minimum two (2) 3 meter duplex (LC/LC) multimode jumpers and two (2) 3 meter duplex (SC-APC/LC) singlemode jumpers provided by the project for every six (6) strands of fiber. The jumpers will be of the same manufacture as the cable and hardware components. University Preferred selection; CCH housings and CCH splice cassette.

Specification for Fiber Optic Cables

Single-mode Optical Fiber in Tight Buffer Cables


A Germania-doped silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD). Each optical fiber refractive index profile shall be step index.

The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

Geometry
2.1 Cladding Diameter (μm) 125.0 ± 0.7
2.2 Core-to-Cladding Concentricity (μm) ≤ 0.5
2.3 Cladding Non-Circularity ≤ 0.7 %
2.4 Mode Field Diameter (μm) 1550 nm
10.4 ± 0.5
2.5 Coating Diameter (μm) 245 ± 5
2.6 Colored Fiber Nominal Diameter (μm) 253 - 259
2.7 Fiber Curl radius of curvature (m) > 4.0 m
2.8 Cabled Fiber Attenuation (dB/km) 1310 nm ≤ 1.0
1383 ± 3 nm ≤ 1.0
1550 nm ≤ 0.75

Multimode Optical Fiber in Tight Buffer Cables

Industry-standard multimode fiber supports 10 Gb/s serial transmission for a guaranteed distance of 300 m using 850 nm VCSEL sources. Fiber supports current network requirements from 10 Mb/s to 622 Mb/s using LED-based protocols and enables cost-effective migration to laser-based protocols such as 10 Gigabit Ethernet, Gigabit Ethernet and 10 Gigabit Fiber Channel (10GFC). Bandwidth-intensive applications and congested backbone links requiring scalability are cost-effectively supported through premises intrabuilding and intrabuilding optical fiber cable plant including local area networks (LANs), storage area networks (SANs) and data centers.

Each fiber in the cable must be usable and meet required specifications. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this specification. A Germania-doped silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD). Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7
GN/m²). The fiber shall be coated with a dual-layer acrylate protective coating. The coating shall be in physical contact with the cladding surface. The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5°C on the original shipping reel. The multimode fiber shall meet TIA-492AAAC, "Detail Specification for 850-nm Laser-Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers."

The core diameter shall be 50.0 ± 2.5 µm. The cladding diameter shall be 125.0 ± 2.0 µm. The cladding non-circularity shall be = 1.0%. The core-clad concentricity shall be = 1.5 µm. The coating diameter shall be 245 ± 5 µm. The optical fiber refractive index profile shall be graded. The numerical aperture of the fiber shall be 0.200 ± 0.015.

The maximum cabled fiber attenuation shall be 3.0 dB/km at 850 nm and 1.5 dB/km at 1300 nm for all cable types. The cabled optical fiber shall have a minimum effective modal bandwidth (EMB) of 2000 MHz•km at 850 nm in accordance with FOTP-220 for 10 Gigabit Ethernet. The cabled optical fiber shall have a minimum over-filled launch (OFL) bandwidth of 1500/500 MHz•km at 850/1300 nm. The cabled optical fiber shall have a minimum restricted mode launch (RML) bandwidth of 1400 MHz•km at 850 nm in accordance with FOTP-204 for Gigabit Ethernet.

The cabled optical fiber shall support industry-standard IEEE 802.3 10GBASE-S (10 Gigabit Ethernet at 850 nm) physical layer specifications for 300 m. The cabled optical fiber shall support industry-standard IEEE 802.3 1000BASE-SX (Gigabit Ethernet at 850 nm) physical layer specifications for 1000 m and 1000BASE-LX (Gigabit Ethernet at 1300 nm) for 600 m. The cabled optical fiber shall support industry-standard multi-gigabit Fiber Channel physical interface specifications.

There shall be no point discontinuity greater than 0.2 dB. The attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at 1300 nm by more than 3.0 dB/km. The attenuation due to 100 turns of fiber around a 75 mm diameter mandrel shall not exceed 0.5 dB at 850 nm and 1300 nm.

**Riser Rated Distribution Interlocking Armored Cable, 2-24 Fibers**

Cable shall be riser-rated with 2 to 24 900 ± 50 µm tight-buffered fibers. TBIIL® Tight-Buffered Fiber shall be made of a PVC material and shall have a UV-cured acrylate coating (low-friction slip layer) between the acrylate coating of the optical fiber and the PVC buffer. The fiber coating, low friction slip layer and PVC buffer shall be removable with commercially available stripping tools in a single pass for termination or splicing. The individual fibers shall be color-coded for identification. The optical fiber color coding shall be in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Fibers shall be stranded together around dielectric strength members or a glass reinforced plastic (GRP) via reverse oscillation and surrounded with dielectric strength members. Cables containing 12 to 24 fibers shall have a dual-layer stranded design. Cable shall contain a ripcord underneath cable jacket to facilitate jacket removal. The cable jacket color shall be orange for cables containing all multimode fiber, except for cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. The cable jacket color shall be yellow for cables containing all single mode fiber. Hybrid cables (containing more than one type of fiber) shall have an outer jacket with the color corresponding to the greatest percentage of total fibers within the cable, except for hybrid cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. Unique color identification of all fibers within the hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. A spirally wrapped interlocking aluminum tape (interlocking armor) shall encase the cable. The cable with interlocking armor shall be available with an additional outer flame-retardant jacket. The color of the outer jacket shall match the jacket color of the optical fiber cable located underneath the armor. The interlocking armor for these cables shall be comparable to liquid tight flexible metal conduit if jacketed, or flexible metal conduit if not. Cables with a flame-retardant jacket over interlocking armor shall be marked with the manufacturer's name, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every 2'. The marking shall be in contrasting color to the cable jacket. Cables without a flame-retardant outer jacket shall not be marked on the interlocking armor.

Cable shall have a storage temperature range of -40° to +70°C, installation temperature range of -10° to +60°C, and an operating temperature range of -20° to +70°C. Cable shall be listed OFCR/FT-4 and be fully compliant with ICEA S-83-596. Cable manufacturer shall be ISO 9001 registered. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support.

**University Preferred Selection:** Corning Cable Systems part number 006E81-31131-A1 for single-mode, and 006T81-31180-A1 for 50 micron multimode LOMMF.

**Plenum Rated Distribution Interlocking Armored Cable, 2-24 Fibers**

Cable shall be plenum-rated with two to twenty-four 900 ± 50 µm tight-buffered fibers. TBII® Tight-Buffered Fiber shall be made of a PVC material and shall have a UV-cured acrylate coating (low-friction slip layer) between the acrylate coating of the optical fiber and the PVC buffer. The fiber coating, low friction slip layer and PVC buffer shall be removable with commercially available stripping tools in a single pass for termination or splicing. The individual fibers shall be color-coded for identification. The optical fiber color coding shall be in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Fibers shall be stranded together around jacketed or non-jacketed dielectric strength members via reverse oscillation and surrounded with dielectric strength members. Cables containing 12 to 24 fibers shall have a dual-layer stranded design. Cable shall contain a ripcord underneath cable jacket to facilitate jacket removal. The cable jacket color shall be orange for cables containing all multimode fiber, except for cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. The cable jacket color shall be yellow for cables containing all single mode fiber. Hybrid cables (containing more than one type of fiber) shall have an outer jacket with the color corresponding to the greatest percentage of total fibers within the cable, except for hybrid cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. Unique color identification of all fibers within the hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. A spirally wrapped interlocking aluminum tape (interlocking armor) shall encase the cable. The cable with interlocking armor shall be available with an additional outer flame-retardant jacket. The color of the outer jacket shall match the jacket color of the optical fiber cable located underneath the armor. The interlocking armor for these cables shall be comparable to liquid tight flexible metal conduit if jacketed, or flexible metal conduit if not. Cables with a flame-retardant jacket over interlocking armor shall be marked with the manufacturer's name, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every 2' (e.g., "MANUFACTURER NAME - 01/00 - 12 SM - TB2 - OFCP (ETL) OFC FT6 (CSA)0001 FEET"). The marking shall be in contrasting color to the cable jacket. Cables without a flame-retardant outer jacket shall not be marked on the interlocking armor.

Cable shall have a storage temperature range of -40° to +70°C, installation temperature range of 0° to +60°C, and an operating temperature range of 0° to +70°C. Cable shall be listed OFCP/FT6 and be fully compliant with ICEA S-83-596. Cable manufacturer shall be ISO 9001 registered. Cable manufacturer shall have a minimum of 10 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support.

**University Preferred Selection:** Corning Cable Systems part number 006E88-31131-A3 for single-mode and 006T88-31180-A3 for multimode 50 micron multimode LOMMF.

**FIBER OPTIC HARDWARE**

**Rack-Mountable Hardware - 3U Rack Space**

Primary Application: Used when both patch panel and splice storage is needed, such as during pigtail splicing.

Housings shall be mountable in an EIA-310 compatible 465 or 592 mm rack and shall be 3 rack units in height as specified by the systems design. Manufacturer shall be ISO 9001 and TL 9000 registered. One EIA rack space or panel height (denoted as 1U) is defined as being 44.45 mm in height. The unit shall be modular with a splicing compartment and a termination compartment in a single housing. The unit shall meet the design requirements of ANSI/TIA/EIA-568 and the polymer compounds flammability requirements of UL 94 V-0. Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. Assembly hardware and equipment-attaching-machine screws shall be included and shall be black in color. The unit shall have patch cord routing guides that allow a transition and segregation point for jumpers exiting the sides of the housing. The unit shall have an open top panel that allows jumper routing through the top of the housing. This shall interface with a separate jumper.
management panel to ease administration and access in higher-density applications. An optional cover shall be available to close off this open top if jumper routing out the top of the housing is not desired. The 3U housing shall hold four patch panels.

Splice capacity for the 3U housing shall be four 0.2” splice trays or two 0.4” splice trays. Either unit shall include a clamshell-type cable clamping mechanism to provide cable strain-relief. The front and rear doors shall be lockable when used with an optional key lock kit. The housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606. The Connector Housings shall be available with factory-installed connectorized cable stubs in multiple cable and connector types. Brackets shall be available that allow wall mounting of the Rack-Mount Hardware.

**University Preferred Selection:** Closet Connector Housing (CCH) shall be Corning Cable Systems part number CCH-02U & 03U or for 2- and 3-rack-unit-high housings respectively.

**FIBER OPTIC CONNECTOR PANELS**

Primary Application: The panels are used with field-installable connectors or in applications where the preconnectorized cables are routed directly from the equipment to the piece of interconnect hardware.

The fiber optic connector panels shall be offered in 6-, and 12-fiber versions. The panels shall be able to be used with field-installable connectors or in applications where the preconnectorized cables are routed directly from the equipment to the interconnect hardware. The 6-fiber panels shall be offered in ST® compatible, FC, SC simplex. The 12-fiber versions shall include ST Compatible Connector, FC, LC duplex, and the SC duplex.

The fiber optic connector panels shall be designed to accommodate applications requiring specified labeling and connector identification. This shall be accomplished by the use of colored snap-in icons with different symbols molded into the icon. The colored icons shall be offered in a variety of colors. As a minimum, these icons shall be available with the following symbols: computer terminals (for fiber-to-the-desktop), telephones, video cameras, CATV, satellite dish or CAT 5e. The icons shall also be available in a variety of colors, including blue, yellow, red, white, electric ivory, ash, green, purple, gray, black, brown and orange. All the icons and colors shall be compliant with the TIA/EIA-606 labeling standard. Panels that accept icons shall come standard with the “blank red” icon. Rack- and Wall-Mountable Connector Housings shall accept an interchangeable connector panel.

The panel shall be attached with two push-pull latches to allow quick installation and removal. Blank connector panels shall be available to fill unused space within the housings. The blank connector panel shall be attached with at least two push-pull latches to allow quick installation and removal. The blank panels shall be manufactured from injection-molded polycarbonate. Panels shall be manufactured from 16-gauge cold rolled steel or injection-molded polycarbonate for structural integrity.

**University Preferred Selection:** Corning LC compatible multimode 50 micron LOMMF shall be CCH-CP06-E4. Corning SC/APC compatible single mode 8.3 micron shall be CCH-CP06-6C.

**FIBER OPTIC PRETERM SPLICING**

Splicing of preterm tails will take place in approved termination housings using splicing cassettes. Add connector panels to cassettes as needed.

**University Preferred Selection:** Corning Cable Systems CCH-CS.

**PRETERM FIBER OPTIC TAILS**

All preterm fiber optic tails will be fusion splice method for both multimode and single mode applications; at no time will mechanical splicing be acceptable. Preterm tails for multimode will be duplex LC connectors. Preterm tails for single mode will be simplex SC/APC connectors.

**University Preferred Selection:** Corning Cable Systems 050006s8180003M for multimode. University Preferred Selection; Corning Cable Systems 440006R8131003M for single mode.
FIBER OPTIC TESTING PROCEDURES

1. OCIO will be notified one week in advance of testing to arrange personnel to be present during testing.
2. Riser cables will be tested with light source and power meter with only one strand being tested at a time. There are to be no "combo" units allowed (Cat 6 tester and a fiber tester in one unit). Fiber will be tested at 850 nm and 1300 nm for multimode cable, 1310 nm and 1550 nm for singlemode cable. Factory calibration must be current for the fiber optic testers, factory documentation must be provided in submittals.
3. Each strand will be tested and electronically stored. Once testing is complete results will be download and turned over to the OCIO Electronically with manufacturer viewing software accompanying results.
4. Multimode testing will be performed using TIA/EIA-526-14-B Method B for in building riser cables. Encircled Flux testing is a requirement, proper mandrels must be used.
5. Single mode testing will be performed using TIA/EIA-526-7 Method A.1 for in building riser cables. For outside plant cables TIA/EIA-52607 Method A.1 and Method B will be used. If issues arise in the building riser cables it will be the responsibility of the contractor to supply an OTDR for further testing and trouble shooting.

All Fiber Optic cables shall be run from the MDF to each IDF. The only allowable splicing is within the fiber termination housing for the pre-terminated tails. **All Fiber Optic Cable inside of buildings will be run in innerducts or be Armored for protection.** These innerducts will be placed in cable trays, in riser sleeves, or any conduits that share fiber and copper. Innerducts will be sized with 50% fill capacity upon initial use. Starting in July of 2010 all new buildings will have Armored fiber only, run from MDF to each IDF.

Fiber Optic in Ducts and Conduits:

Provide cable lubricant compatible with the cable sheathing material when pulling cable. Attach pulling fixtures to the cable strength members. When indirect attachments are used, match the grip diameter and length to the cable diameter and characteristics. When indirect attachment is used on cables having only central strength members, reduce pulling forces to ensure that fibers are not damaged from forces being transmitted to the strength member. During pulling of the cable, continuously monitor pull line tension, and shall not exceed maximum tension given by the cable manufacturer. Mechanical stress placed upon the cable during installation shall be such that cable in not twisted or stretched. Provide cable feeder guide between cable reel and face of duct or conduit to protect and guide cable into the duct or conduit as it is played off of the reel. As cable is played off of the reel, carefully inspect the jacket for defects. Take precautions during installation to prevent the cable from being kinked or crushed and that the minimum bend radius is not exceeded at anytime. Hand feed and guide cable through each junction box and apply additional lubricant at intermediate junction boxes. When practicable, use the center pulling technique to lower pulling tension. When the cable is pulled out of a junction box protect from dirt and moisture.
Section V   THE OHIO STATE UNIVERSITY OUTSIDE PLANT STANDARDS

The purpose of this document is to provide guidelines for installation of outside plant facilities including building entrances, maintenance holes, conduit, and tunnel entrances. These guidelines are to be used as a means to provide minimum requirements. Specific requirements for each project will be coordinated with the using agency and an Office of the CIO Telecommunications and Networking outside plant management team during project development.

GENERAL
Office of the CIO personnel should be consulted during the planning stages of any building construction or building renovation. In some cases, present Entrance Facilities (EF), Main Distribution Frame (MDF), and Intermediate Distribution Frame (IDF) may have to be enlarged or redesigned to accommodate changes in the use of building space.

All cable that is to be connected to or disconnected from the campus communication network must be done by Office of the CIO personnel. The customer must contact Office of the CIO six weeks prior to installation of any new facilities needing placed (if temporary service must be placed it will be done at the cost of the project). Contractors must submit a request on company letterhead for both installation and removals, they can be faxed to 614.688.3425, questions can be directed to 614.688.HELP option 2. The request to connect/disconnect/or move must follow established guidelines. Cabling must be removed back to the source once disconnected (disconnect to be done by Office of the CIO) by the contractor.

Office of the CIO will review drawings and specifications on construction and renovation projects for compliance with the University Outside Plant Standards. Office of the CIO will approve drawings and specifications through the Architects Office.

Prior to ordering of materials selected contractor must turn in submittals 6 weeks in advance for Office of the CIO to approve/disapprove. In addition to all other required copies of submittals, Submit two copies to OCIO through the project manager for review by OCIO.

Any project that requires moving or rerouting of telecommunications and networking cables will bear the cost of said moves.

All pathway work will be paid by project funding.

All materials specified shall be UL listed and in accordance with the most recent versions of the following codes and agencies:

The National Electrical Code
National Fire Code
Life Safety Code
National Electronic Manufacturers Association
Institute of Electronic and Electrical Engineers
EIA/TIA standards

All as-builts will be turned over to the Office of the CIO Outside Plant Department within 2 weeks of completion. The as-built will contain linear measurements of conduit, and locations of manholes and conduit relative to a visible measuring point. This can be off the face of a building or the back of a curb. These measurements should be two directional. It is understood that GPS can also be used as long as it is tied to the Campus Mapping System.

Office of the CIO designers shall have access to construction sites.

To enable Office of the CIO to inspect telecommunications and networking facilities work, the contractor must:

Provide a progress schedule with the installation of telecommunications and networking raceways and spaces shown as a separate item.
Immediately notify Office of the CIO of any change in architectural drawings and/or plans affecting Office of the CIO facilities.

Provide proper access and facilities for inspections.

Notify Office of the CIO when any work is ready for inspection.

All underground work shall be inspected and approved by Office of the CIO through the University Project Manager, before the site is covered. Failure to have the work inspected shall result in uncovering the area at the contractor's expense.

1. Outside Plant Pathway and Entrance Facilities

1.1 INTRODUCTION

This section provides the necessary guidelines to install service entrances to buildings and information for the termination of cables entering buildings. Topics addressed are voice, data, and video.

Prior to start of work on any project, all outside plant voice, data, video cabling, conduit and manholes shall be designed by the Office of the Chief Information Officer (OCIO) Outside Plant Department.

All outside pathways for outside plant cabling shall be designed by the A/E and must be reviewed and approved by the OCIO prior to start of any work on a project. Submittals must be turned in for all materials to be used in the outside plant project and approved prior to start of installation.

The project must give 6 weeks' notice for installation of outside plant cables to provide service to the building. If service must be placed temporarily, the project will cover the cost of the temporary installation.

1.2.1 GENERAL

All cables associated with the campus telecommunications network (telephone, data, LAN, WAN, campus TV, and fiber optics) shall be connected and disconnected by Office of the CIO or its designate. Office of the CIO will provide main feed cables to each building, including placement and terminations of each cabling medium (voice, data, and video). The Project (building contractor) will be responsible for pathway to new/renovated building from the nearest manhole/tunnel or point of feed designated by Office of the CIO Outside Plant Department. These pathways must meet Office of the CIO standards and meet all NEC codes. These pathways are for only low voltage cables.

1.2.2 AERIAL

Most university low voltage cabling is underground. No aerial cabling shall be installed on campus unless approved by Office of the CIO and/or the University Architects' Project Manager.

1.3 CONDUIT

1.3.1 GENERAL

Conduit sizing and quantities between buildings shall be determined by Office of the CIO and will be communicated to the FOD Design & Construction Project Manager for inclusion in the project specifications. Minimum requirements are outlined in the following paragraphs.

Prior approval and coordination with Office of the CIO, FOD Design & Construction Project Manager, and other concerned parties is necessary when the situation requires any modification to the conduit system.

Repair or replacement of damaged conduit is the responsibility of the party involved in causing the damage. All damages shall be reported to Office of the CIO, Construction Management and Facilities Management immediately.

Since communications and networking is vital to departments, redundant entrances to new buildings/renovations will be looked at during the initial design phase to be included in the overall scope of the project.
It is the responsibility of the contractor to notify O.U.P.S. at 1-800-362-2764, 72 hours prior to start of construction, excluding holidays and weekends, for all utility markings. Those utilities that are not listed with O.U.P.S. must also be notified by the contractor. The Ohio State University's Facility Operations Development must also be contacted prior to construction for the University's private utility locates.

It will be the responsibility of the project to obtain the necessary permits involved in placing Office of the CIO conduit/cable through public right of ways. Costs for this process must be preapproved by the project prior to obtaining the permits.

When crossing privately owned properties with Office of the CIO facilities, easements shall be coordinated by Office of the CIO Outside Plant Department and The Ohio State University's Physical Planning and Real Estate (PPARE) Department.

As-built drawings will be provided upon completion of installation of all Office of the CIO outside plant in Auto-Cad format and 2 paper copies. Construction prints shall be clearly marked as to the location of the conduit that was placed. Where structures and features exist in the field, measurements must be taken both perpendicular to an edge or face of the structure and distance must be shown from the closest corner, beginning, or end of the existing structure. If no such references can be demonstrated, the Contractor shall establish a baseline reference that can be located easily in the future. All conduit will show a final measurement, e.g., 788'F. Wherever the ductbank crosses over or under existing utilities, the contractor must identify the service and pipe diameters crossed. Construction shall leave separation between found utilities which will be dictated by the utility crossed. The vertical separation shall be documented on the as-built. Vertical depths must be shown on the as-built drawings from the top of duct (encasement) to the existing grade. Whenever there is a change from the 36" standard cover due to unforeseen obstacles, Office of the CIO must be notified as to the problem prior to change. It shall be required that the FOD Mapping staff is notified to take GPS readings while the newly placed conduit and/or utilities are exposed.

1.3.2 REQUIREMENTS

All new facilities or renovations will be subject to meet minimum requirements. A minimum of 2-4" (I.D.) PVC encased will be required for every new building for the placement of voice, data, and video. Conduit is to be placed at 36" below grade to top of encasement, unless approved by Office of the CIO, for each entrance.

Conduits will not feed building to building.

Duct banks will be placed as straight as possible, with bends kept at a minimum there will a minimum of a 20' radius on all conduit installations requiring bends. There will be no more than 180 degrees of bend in a section. Office of the CIO Outside Plant Department must approve all duct bank/manhole installations prior to start.

A Kevlar pull string or a measure tape shall be installed and tied off in each conduit. Pull wires used in outside conduit shall be stainless steel or copper; #12 AWG or strings shall be of the Kevlar type. From the MPOE (main point of entry), rigid metallic conduit will be used inside the building to the EF (entrance facility). The entrance facility must be within 50’ of the MPOE. The minimum size for the Entrance Facility (EF)/Main Distribution Frame (MDF) is 400 square feet. The preferable dimensions are 20'x20'. All usable walls will be covered in 3/4" x48"x96" type APA A-D Group 1 plywood, fire retardant treated, with the A side facing the room. These rooms will be shared with computers, telephone equipment and data network equipment and racks. Office of the CIO shall be contacted for final dimension approval.

1.3.3 UNDERGROUND

All underground conduits and ducts, rigid or PVC, added to a project shall be added in groups of 2, 4, 6, 8, 10, 12 or more. Under no circumstances are single underground conduit runs acceptable.

All underground conduit, duct bank and raceways shall be concrete encased (2500psi minimum). Additional reinforcement is to be used when crossing roadways or when recommended by the University Architects’ Project Manager.

The minimum separation for communications ducts and power ducts in a joint trench environment is 3” (8 cm) of concrete, 4” (10 cm) of masonry or 12” (30 cm) of well-tamped earth. All communications ducts shall also be a minimum of 48” from steam pipes and condensation lines. If crossing perpendicular, Gillsulate insulation (or
Office of the CIO/FOD approved equal) must be placed over the top or underneath the encasement to reduce the risk of damage due to heat. The minimum depth for buried conduit and ducts is 36" to the top of the encasement from grade or underside of roadbed to top of concrete.

When communication ducts run parallel to steam lines, a minimum of a 2' separation is required, and Gillisulate insulation must be on the side facing the steam line to reduce the risk of damage due to heat. All other duct separations must comply with the National Electric Code.

Rigid steel conduit, encased in reinforced concrete with 5/8" rebar placed on 5" on center shall be used in any location subject to abuse, such as under roadways, slabs or foundations.

All underground conduits shall be 4" inside diameter.

All necessary precautions shall be taken by the contractor during construction to prevent the lodging of dirt, plaster, concrete or trash in all conduit. All conduit in floors, concrete or below grade shall be swabbed free of debris and moisture before wires are pulled. All conduit shall have duct plugs (expandable mechanical) installed at the building entrance to prevent water migration into the building. All building entrances will be sloped to drain back towards the manhole. Under no circumstances will a manhole be placed above the entrance to a building allowing it to drain towards the building.

1.3.4 TUNNELS

Where conduit, ducts or cable trays are in tunnels, they shall be kept at least 24" from parallel runs of flues, steam pipes, hot gas pipes, hot water pipes or any other utility line which is hot during normal operation of the facility it serves. It is the preference of Office of the CIO Outside Plant Department that all communication cabling is placed opposite the steam side of tunnels. All conduit sections crossing steam lines shall be rigid and shall be provided with a means of insulation from the steam lines, unless a written exception is provided by the FOD Design & Construction Project Manager and Office of the CIO Outside Plant Department.

1.3.5 TRAPS

All conduit, tubing, raceways, ducts and duct banks shall be installed in such manner to insure against collection of trapped condensation. Raceway runs shall be arranged to be void of traps.

When conduit passes through exterior concrete walls of any facility, the entrance shall be watertight. Pipe sleeves, at the conduit entrance, shall be sized large enough to place Link Seals between the sleeves and entrance conduit. Link Seals will be placed on both sides of the entrance.

1.3.6 TYPES

Abandoned gas, water, steam and any pipes that might contain asbestos insulation shall not be used as telecommunications and networking conduit under any circumstances.

Four types of conduit are accepted for underground conduit systems. Project specifications will detail the types of conduit to be used in the various locations covered by the project.

Rigid galvanized steel conduit with threaded fittings. This conduit shall be installed with concrete casing in areas subject to abuse. If not concrete encased, this conduit shall be painted with 2 coats of coal tar base paint or have epoxy coating applied by manufacturer.

Schedule 40 PVC conduits. This conduit shall be installed with concrete encasement. No PVC conduit is acceptable without concrete, unless specified by Office of the CIO Outside Plant Department.

“C”-Duct conduit: This conduit shall be installed only with concrete encasement.

HDPE SDR11 or Bore Guard schedule 40: These are to be used for only directional boring. Boring must be preapproved by Office of the CIO.

Rigid steel conduits installed underground without concrete encasement shall be field-wrapped with 0.01" thick pipe-wrapping plastic tape applied with a 50 percent overlap, or shall have a factory applied plastic resin, epoxy
or 2 coats of a field-applied coal tar specifically made for this purpose. If the coal tar coating method is used, the contractor shall notify Office of the CIO prior to backfilling for inspection and approval of the coating before the conduit is covered.

Field wrapping or coating shall extend to 6" above ground level where conduit is installed by a pole or side structure or inside a pedestal.

The duct encasement shall be rectangular in the cross section and be a minimum concrete thickness of 2" around any conduit. The duct encasement shall be sized and placed as shown on construction documents.

All conduit and ducts must be terminated with bell ends at the manhole, facility or other termination point.

Duct spacers shall be provided at a maximum of 5' intervals. Conduit shall be anchored at 3'-6" intervals and at each spacer to prevent duct floating during concrete installation.

**Emergency phones**

1.3.7 Entrance Facility

The Entrance Facility (EF) in the building must be placed within 50’ of the MPOE (main point of entry). At the MPOE of the building, rigid metallic conduit (number of rigid metallic conduits equal them number of conduits entering the building) must be placed to the EF. All unlisted OSP cables will be placed in rigid conduit.

1.4 MANHOLES

1.4.1 GENERAL

Manhole sizes may vary depending on space limitations. All manholes shall be placed in accordance with the manufacturer’s specifications and all required safety regulations. All manholes shall be placed with a collar height of 18” minimum. Locking lids are required and shall be 30” in diameter with “COMMUNICATIONS” engraved on the lid. Manhole lids will not have recessed handles that pull out. All holes will be precast. See material list for acceptable manufacturer and part numbers.

Handholes must be approved by an Office of the CIO Outside Plant Designer.

The maximum distance between manholes connected in any one run shall not exceed 500’. Unless approved by Office of the CIO Outside Plant Department.

All telecommunication manholes /handholes must be placed in accordance with manufacturer’s specifications unless special conditions are approved by Office of the CIO Telecommunications and Networking Outside Plant Department.

All Telecommunication Precast manholes/handholes shall include the associated hardware package (for racking), ladder, frame and cover, and collar (neck), for the specific structure being placed. Note: Lids must be marked as Communications.

See below for approved product vendor or OCIO approved equal:

**Concrete Precast Manholes/Handholes:**
Oldcastle Hartford Concrete Products
1400 North Wabash Avenue
P.O. Box 660
Hartford City, Indiana 47348-0660
1-800-428-8110
Telefax: 765-348-3121

1.4.2 Manhole Interior
All materials used in a manhole shall be resistant to corrosion. All steel shall be galvanized or zinc coated. All racking in manholes shall be in accordance with manufacturers’ specifications. Manholes shall have pulling rings opposite to the conduit entrance on each wall.

1.4.3 Restoral

All surfaces must be restored to like or better condition as soon as possible. Where settling occurs, it is the responsibility of the contractor to correct the given area and take appropriate measures to reseed and regrade as necessary at no additional charge to the project or Office of the CIO. The contractor is responsible for 1 year from project completion date.

1.5 SPECIAL CONSIDERATIONS

For the items listed below Outside Plant services must be installed into the building prior to being able to install service. Notification must be given to Office of the CIO at least 6 weeks in advance to needing service. If temporary service must be placed it will be at the contractor/project expense. All service orders must be on company letter head (or microform if a University entity) and faxed to 614.688.3425. For questions regarding service contact 614.688.HELP option 2.

**EMERGENCY PHONES**

1. Cable will have water blocking compounds to prevent intrusion of moisture.
2. Materials suitable for -40 degree C to +80 degree C operation range.
3. Cable shall be Mohawk Versalan Cat 6 or OCIO approved equal.
4. Lightning protectors must be provided for both ends of cable. All four pairs of the cable must be protected. Each unit must be grounded at both ends. Protectors shall be or equal to L-Com part # AL-Cat6JW or L-Com HGLN-Cat6J or Office of the CIO-approved equal.
5. Electrical contractor to provide ground at stanchion.
6. One 2” conduit will be placed for low voltage communications to each stanchion from the nearest building telecommunications room. Once inside the building, the 2” conduit will be rigid metallic conduit.
7. Meets Category 6 transmission requirements of ANSI/TIA/EIA 568C.
SECTION VI: DEFINITIONS

COMMUNICATION OUTLET

Any outlet designated for voice, data, or video. The termination point of the station wire will have an RJ11, RJ41, RJ45, BNC, F connector, or any other modular jack assembly installed. This outlet will be used for the connection of telephone, modem, data path, balun, or other device used to establish voice, data, or video communications.

DATA TERMINATION JACK (SEE Communication Outlet)

TELEPHONE JACK (SEE Communication Outlet)

UNDERGROUND CABLE

The cable that enters the building from the Campus Distribution Network.

ENTRANCE CABLE (SEE Underground Cable)

OUTSIDE PLANT CABLE (SEE Underground Cable)

INTERMEDIATE DISTRIBUTION FRAME (IDF)

The point where the riser cables and the station wire (ISW) come together. There can be more than one IDF in a building or on a floor.

MAIN DISTRIBUTION FRAME (MDF)

That point in the building where the underground cable is terminated on 66M150 type blocks. The riser cable is also terminated on 66M150 blocks at this location. The underground cable is cross-connected to the riser cable by a jumper.

RISER CABLE

The cable that runs between the IDF and the MDF.

JUMPERS

Two wires (1 pair) that connect the underground cable pairs to the riser cable on the 66M150 blocks at the MDF and the station wire to the riser cable at the IDF.

CROSS-CUT WIRE (SEE Jumpers)

SPLICE

A point where two cables are mechanically connected to each other.

STATION WIRE

A wire or cable used to connect the communication outlet to the IDF. This is to be a 3 pair wire without shield, 4 pair wire without shield, coaxial, or other as required.

INSIDE WIRE (ISW) (See Station Wire)

TBB

Telecommunications Bonding Backbone.

“OR OCIO APPROVED EQUAL”

Whenever the term “or OCIO approved equal” appears in this document it means the product must be the same size, shape, color and function as the product specified.
CATV Specifications for 75 Ohm Coaxial Cable

**Series 6 Cable P/N= GF-URS-6 (non-plenum type)**

All cable shall be “Quad Shield.”
Minimum SRL shall be –20 dB 5 to 950 MHz and -15 dB 950 to 2200 MHz.
Minimum Velocity of Propagation shall be 85%.
Maximum attenuation for non-plenum type cable at 68 degrees F (20 degrees C) is listed in the following table:

<table>
<thead>
<tr>
<th>Frequency in MHz</th>
<th>dB/100ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.25</td>
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<tr>
<td>10</td>
<td>.66</td>
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<tr>
<td>50</td>
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<tr>
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<td>200</td>
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<td>900</td>
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<td>1200</td>
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<td>1800</td>
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<td>2500</td>
<td>9.97</td>
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<tr>
<td>3000</td>
<td>10.92</td>
</tr>
</tbody>
</table>

Maximum attenuation for plenum type cable at 68 degrees F (20 degrees C) is listed in the following table:
**P/N= GF-UR-6-PL (Plenum type)**

<table>
<thead>
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<th>dB/100ft</th>
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<td>50</td>
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<td>11.70</td>
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<tr>
<td>3000</td>
<td>13.07</td>
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Series 11 Cable P/N= GAF-URS-11-MH (Non-plenum type)

All cable shall be “Quad Shield.”
Minimum SRL shall be –20 dB 5 to 950 MHz and -15 dB 950 to 2200 MHz.
Minimum Velocity of Propagation shall be 85%.
Maximum attenuation for non-plenum type cable at 68 degrees F (20 degrees C) is listed in the following table:

<table>
<thead>
<tr>
<th>Frequency in MHz</th>
<th>dB/100ft</th>
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</thead>
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<td>.45</td>
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<tr>
<td>50</td>
<td>.89</td>
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<tr>
<td>100</td>
<td>1.21</td>
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<tr>
<td>200</td>
<td>1.68</td>
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<td>3000</td>
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Maximum attenuation for plenum type cable at 68 degrees F (20 degrees C) is listed in the following table:

P/N= GAF-UR-11-PL (Plenum type)

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<th>Frequency in MHz</th>
<th>dB/100ft</th>
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<tr>
<td>50</td>
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<tr>
<td>100</td>
<td>1.28</td>
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<tr>
<td>200</td>
<td>1.85</td>
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<td>400</td>
<td>2.75</td>
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<tr>
<td>700</td>
<td>3.92</td>
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<td>900</td>
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<td>2200</td>
<td>8.50</td>
</tr>
<tr>
<td>3000</td>
<td>9.88</td>
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</table>
PULL AND SPLICES BOXES

A PULL BOX SHOULD BE PLACED WHERE CONDUIT RUNS EXCEED 100 FEET IN LENGTH OR CONTAIN THE EQUIVALENT OF MORE THAN TWO 90-DEGREE BENDS. CONDUIT SHOULD ENTER AND LEAVE THROUGH OPPOSITE ENDS OF THE BOX. NO BENDS SHOULD BE MADE INSIDE THE BOX. IF A 90-DEGREE TURN IS REQUIRED AT A BOX, IT IS PREFERABLE TO PLACE IT ADJACENT TO THE BOX, AS ILLUSTRATED IN (A) AND (C). DO NOT PLACE THEM AS ILLUSTRATED IN (D), (E), AND (F).

THESE SAME CONSIDERATIONS APPLY TO SPLICE BOXES PLACED AT TURNS.

Exhibit B

See Exhibit C for sizes.
MINIMUM RECOMMENDED SIZES OF PULLBOXES AND SPLICE BOXES

If slip sleeves, gutters, or open sections of conduit are used instead of pull boxes, the opening should be as long as the pull box specified below.

### PULL BOX SIZES
FOR TWO CONDUITS  (IN.)

<table>
<thead>
<tr>
<th>Nominal Conduit Size (in.)</th>
<th>Configurations</th>
<th>Configurations</th>
<th>Configurations</th>
<th>For each additional conduit add (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a) or (b) or (c)</td>
<td>(e)</td>
<td>(f)</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>L</td>
<td>D</td>
<td>W</td>
<td>L</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>16</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>1-1/4</td>
<td>6</td>
<td>20</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>1-3/8</td>
<td>8</td>
<td>27</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>36</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>2-3/8</td>
<td>10</td>
<td>42</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>48</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>3-3/8</td>
<td>12</td>
<td>54</td>
<td>6</td>
<td>21</td>
</tr>
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</table>

### SPLICE BOX SIZES
FOR TWO CONDUITS  (IN.)

<table>
<thead>
<tr>
<th>Configurations</th>
<th>Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) or (b)</td>
<td>(d) or (e)</td>
</tr>
<tr>
<td>W</td>
<td>L</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
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<tr>
<td>1-1/4</td>
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<td>2</td>
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</tr>
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<td>3</td>
<td>30</td>
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<tr>
<td>3-3/8</td>
<td>36</td>
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<tr>
<td>4</td>
<td>42</td>
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</tbody>
</table>

Exhibit C
### MINIMUM BEND RADIUS OF CONDUITS

<table>
<thead>
<tr>
<th>SIZE OF CONDUIT INCHES</th>
<th>CROSS SECT AREA SQ. INCHES</th>
<th>MINIMUM RADIUS OF CONDUIT BEND NON-LEAD SHEATH INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>0.53</td>
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</tr>
<tr>
<td>1</td>
<td>0.86</td>
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<td>1.25</td>
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<tr>
<td>1.5</td>
<td>2.04</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>30</td>
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<tr>
<td>5.5</td>
<td>28.89</td>
<td>35</td>
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</tbody>
</table>

Exhibit D
### CAT 6 CONDUIT CABLE FILL WITH 180 DEGREES OF BENDS

<table>
<thead>
<tr>
<th>CONDUIT TRADE SIZE</th>
<th># OF CABLES</th>
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<tbody>
<tr>
<td>1&quot;</td>
<td>4</td>
</tr>
<tr>
<td>1.5&quot;</td>
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<tr>
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</tr>
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<td>3&quot;</td>
<td>45</td>
</tr>
<tr>
<td>4&quot;</td>
<td>75</td>
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</table>

### CAT 6A CONDUIT CABLE FILL WITH 180 DEGREES OF BENDS

<table>
<thead>
<tr>
<th>CONDUIT TRADE SIZE</th>
<th># OF CABLES</th>
</tr>
</thead>
<tbody>
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<td>2&quot;</td>
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<tr>
<td>3&quot;</td>
<td>17</td>
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<tr>
<td>4&quot;</td>
<td>29</td>
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</table>

### CAT 6 CONDUIT CABLE FILL NO BENDS/OFFSETS

<table>
<thead>
<tr>
<th>CONDUIT TRADE SIZE</th>
<th># OF CABLES</th>
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<tbody>
<tr>
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<tr>
<td>2&quot;</td>
<td>24</td>
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</table>

### CAT 6A CONDUIT CABLE FILL NO BENDS/OFFSETS

<table>
<thead>
<tr>
<th>CONDUIT TRADE SIZE</th>
<th># OF CABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
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<tr>
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<tr>
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Exhibit E
Exhibit F
TYPICAL IDF LAYOUT

3/4" PLYWOOD

Exhibit G
<table>
<thead>
<tr>
<th>Pair</th>
<th>TIP COLOR</th>
<th>RING COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
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<td>White-Orange</td>
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<td>White-Green</td>
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<td>4</td>
<td>White-Brown</td>
<td>Brown-White</td>
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<tr>
<td>5</td>
<td>White-Slate</td>
<td>Slate-White</td>
</tr>
<tr>
<td>6</td>
<td>Red-Blue</td>
<td>Blue-Red</td>
</tr>
<tr>
<td>7</td>
<td>Red-Orange</td>
<td>Orange-Red</td>
</tr>
<tr>
<td>8</td>
<td>Red-Green</td>
<td>Green-Red</td>
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<tr>
<td>9</td>
<td>Red-Brown</td>
<td>Brown-Red</td>
</tr>
<tr>
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<td>12</td>
<td>Black-Orange</td>
<td>Orange-Black</td>
</tr>
<tr>
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### Exhibit I

**JACK WIRE CODE**

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<th>JACK WIRE CODE</th>
<th>INSIDE WIRE COLOR</th>
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<tr>
<td>GREEN</td>
<td>WHITE-BLUE</td>
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<td>ORANGE-WHITE</td>
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### Exhibit J
Exhibit L
Exhibit M
Exhibit O
TYPICAL IDF LAYOUT

3/4" PLYWOOD

RISER CABLE

STATING

TYPICAL BLOCK

GROUND BAR

FLOOR

48"

EXHIBIT P
## TBB sizing chart

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<th>TBB/GE linear length m (ft)</th>
<th>TBB/GE size (AWG)</th>
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<td>6</td>
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<tr>
<td>4 – 6 (14 – 20)</td>
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<tr>
<td>6 – 8 (21 – 26)</td>
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</tr>
<tr>
<td>8 – 10 (27 – 33)</td>
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<tr>
<td>10 – 13 (34 – 41)</td>
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<tr>
<td>13 – 16 (42 – 52)</td>
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<tr>
<td>16 – 20 (53 – 86)</td>
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<tr>
<td>20 – 26 (67 – 84)</td>
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<tr>
<td>26 – 32 (85 – 105)</td>
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<tr>
<td>32 – 38 (106 – 125)</td>
<td>250 kcmil</td>
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<tr>
<td>38 – 46 (128 – 150)</td>
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<tr>
<td>46 – 53 (151 – 175)</td>
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<tr>
<td>53 – 76 (176 – 250)</td>
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<tr>
<td>76 – 91 (251 – 300)</td>
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<tr>
<td>Greater than 91 (301)</td>
<td>750 kcmil</td>
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Exhibit Q
Exhibit S

End of Appendix M