



The University of Toronto

Communications Infrastructure Specifications, Standards and Practices

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The following revisions have been incorporated since the previous release (April 2019) of this document have been made.

- Telecommunication/TC/TR Room terminology has been changed to “LAN room” where applicable.
- UTP cabling now recommends CAT6A UTP cables instead of CAT6 throughout, exceptions listed in Section 17 and Section 18.
- Painting of cables in LAN rooms is now prohibited. (Section 9.15)
- Cables in pull boxes shall be labelled appropriately. (Section 23.12)
- 28 AWG UTP patch cables are recommended for use in LAN rooms (Section 9.10)
- Glossary of Terms and Abbreviations

Updates February-2024

- LAN room equipment restrictions and exclusions clause (Section 9.0 top)
- LAN room automatic lights shut off (Section 9.6)
- Equipment racks outlet surge protectors (Section 9.11)
- LAN rooms mandatory emergency power for life-critical systems (Section 9.17)
- Outdoor Wireless Access Points (WAP) requirements (Sections 16.8, 16.9)
- 25-year parts warranty from the manufacturer (Sections 22.3, 22.4)
- Naming convention for Wireless Access Points and Cable (Sections 23.16, 23.17)
- Appendix A outdoor WAP installation and grounding requirements

Updates January 2025

- Maximum distance from LAN room to work area and minimum LAN room dimensions (Section 9.1)

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1. OVERVIEW

This document details the general requirements and installation practices developed by and in use at the University of Toronto, and should be used as a reference for contractors performing work on the communications infrastructure at the University. All work shall be performed in accordance with this document unless specific instructions overriding these specifications are provided in the Scope of Work section in the Work Order or tender specification specific to the project.

Note that this document includes specifications for horizontal, intra- and inter-building wiring, some of which may not be applicable to the scope of work provided in the project's work order or tender documents.

2. EMERGENCIES

The emergency number is 416 978-2222. If calling from a University phone dial the local (8-2222) only. If the situation requires quick response, dial the 911 service. If 911 is called the University emergency number must also be notified.

Each Project Manager and Property Manager will have their own list of contacts within their group and the contact must be notified immediately after making an emergency call. The contractor is responsible for advising all crew members of the emergency phone number should an emergency arise while on site.

3. GENERAL

Labour

- 3.1 All cabling installations must be performed by licensed unionized (IBEW) electricians. The electricians must follow the latest safety requirements from the Ministry of Labour.
- 3.2 The contractor shall update customer supplied drawings identifying cable routing and new infrastructure installed. In the case where drawings are not available a schematic drawing indicating building names and other reference points will be included. It is the contractor's responsibility to record the distances of the fibre/copper runs on drawings.

3.3 It is the contractor’s responsibility to ensure that all part numbers identified in the scope and drawings are accurate with the manufacturers. Also, the contractor’s responsibility is to ensure all locations and distances identified in this document are accurate. Any deviations must be brought forward for approval.

Applicable Standards, Guidelines and Practices

3.4 All work must conform to industry accepted practices, manufacturers’ component installation guidelines, the Ontario Building Code, the Canadian Electrical Code, and all applicable standards including, but not limited to:

<u>Standard</u>	<u>Title</u>
ANSI/TIA-568.0-D	Generic Telecommunications Cabling for Customer Premises, Ed. D, 09-2015
ANSI/TIA-568.1-D	Commercial Building Telecommunications Cabling Standard, Ed. D, 09-2015
ANSI/TIA-568-C.2	Balanced Twisted-Pair Telecommunication Cabling and Components Standard
ANSI/TIA-568.3-D	Optical Fiber Cabling and Components Standard, Ed. D, 10-2016
ANSI/TIA-569-D	Telecommunications Pathways and Spaces
ANSI/TIA-606-C	Administration Standard for the Telecommunications Infrastructure
ANSI/TIA-607-C	Telecommunications Bonding and Grounding (Earthing) for Customer Premises
ANSI/TIA-598-C	Optical Fiber Cable Color Coding
ANSI/TIA-526-14-C-	Test procedures for installed multimode fiber cable plant
ANSI/TIA-526-7-A	Test procedure for installed single mode fiber cable plant
ANSI/TIA-604-3	FOCIS 3 Fiber Optic Connector Interminability Standard
ANSI/ICEA S-83-596	Optical Fibre Premises Distribution Cable
ANSI/ICEA S-87-640	Optical Fibre Outside Plant Communications Cable
CSA C22.1	Canadian Electric Code Part 1 Ontario Regulation 10/02 Ontario Hydro Electrical Safety Code
CSA C22.2 No. 232-M	Fiber Optic Cables
CSA-C22.2 No. 182.4-M9	Plugs, Receptacles, and Connectors for Communication Systems
CSA-C22.2 No.214-94	Communications Cables
ISO/IEC 11801	Information technology — Generic cabling for customer premises

4. WORK AREA AND PROJECT RESTORATION

General

- 4.1 The contractor shall be responsible for cleanup of all facilities and buildings related to the project, during and at completion.
- 4.2 The work site and adjacent areas shall be left in the same condition or cleaner than when starting a shift. This must be done daily.
- 4.3 The contractor shall protect exterior and interior building equipment in the immediate and adjacent work areas.
- 4.4 The contractor shall protect existing building finishes and services not affected by the modifications.

Surface Finishes

- 4.5 The general standard is that existing surfaces must be restored and finished back to the original condition or better. The Project or Property Manager shall determine the appropriate and acceptable finish. Contractors must be aware of the site conditions prior to bidding and account for the appropriate resources necessary for this aspect of the project.
- 4.6 Contractor must be trained for asbestos awareness. When penetrating surfaces where there is vinyl asbestos tile, cut and lift the tile prior to coring. Use the lifted tile to restore finishes where possible.
- 4.7 When penetrating terrazzo or concrete surfaces the restored surface must be finished using the same materials. A terrazzo patch kit must be used to restore surfaces that have been damaged beyond a 1/4-inch circumference of the penetrating structure. A patch area must be created that uses straight cuts at right angles to each other or to adjacent walls.
- 4.8 When penetrating carpeted surfaces, cut or lift the carpet prior to coring. Refit the carpet tight to the penetrating structure.
- 4.9 When penetrating wall or floor slabs both sides must be restored to the existing finish.
- 4.10 When painting surfaces use one primer / sealer coat of paint and two or more finish coats of paint. Block or brick walls are to be thoroughly sealed prior to finishing.
- 4.11 Any holes in surfaces created to secure operating equipment must be fully restored.

- 4.12 Any markings on surfaces such as spray paint or liquid markers must be removed, cleaned, and polished where necessary.
- 4.13 Any over painting of structures on to background surfaces may make it necessary to refinish the background area to match the new structure. It is the responsibility of the contractor to pre- determine this condition or to take care in avoiding the situation.

5. X-RAY AND HOLE CORING

- 5.1 The contractor will supply all vertical and horizontal hole cores. X-ray of proposed core locations must be performed prior to coring. Under no circumstances should X-rays be performed without the prior notification and approval of the Project Manager or Property Manager.
- 5.2 When site conditions do not make it feasible to x-ray the contractor must exercise reasonable judgment to evaluate whether there is a chance that coring will cause the severing of electrical, low voltage or any other services that may be in the structure that is being penetrated. The use of hammer chisels may be necessary in some buildings. A thorough inspection of both sides of the surfaces must be performed. A flux scanner to check for live loaded A.C. is to be used prior to any drilling, coring or chiseling. Where applicable the opening of drop ceilings on the undersides of floors, including fixed surfaces, must be done to expose the breakthrough area. Small diameter pilot holes must be drilled prior to the final coring or chiseling.
- 5.3 A qualified electrician with access to a circuit scanner must be present during coring or chiseling should any services be severed. The campus police must be contacted immediately using the emergency number should services be severed. The Project Manager must be notified of these occurrences immediately also. Depending on the circumstance the contractor may be asked to begin restoration procedures of severed services immediately.
- 5.4 Any penetration of structural beams, columns or supports must be cleared by the Project Manager before proceeding.
- 5.5 Patching and making good of coring is the responsibility of the contractor.

6. KEY ACCESS

Contractors will be required to complete a request form to request access to passage keys, needed to perform the work in the buildings. Typically, these keys can be picked up from the University of Toronto Police at 21 Sussex Avenue at the beginning of a work shift and must be dropped off at the end of the work shift to the same location.

Request form located at: [Request-for-contractor-access-to-LAN-and-data-equipment-rooms.pdf](#)

7. FIRE DETECTION SYSTEMS

The fire detection systems in the University can be set off by dust. When work is being performed in proximity to detectors it is necessary to inform The Project Manager 24 hours prior to the work being performed. The Project Manager will arrange with the University's Fire Marshall to have the local devices de-commissioned prior to the start of work. The contractor to ensure fire alarms are deactivated prior to proceeding with any work.

8. BUILDING ENTRANCE FACILITY (REFER TO FIG. 1)

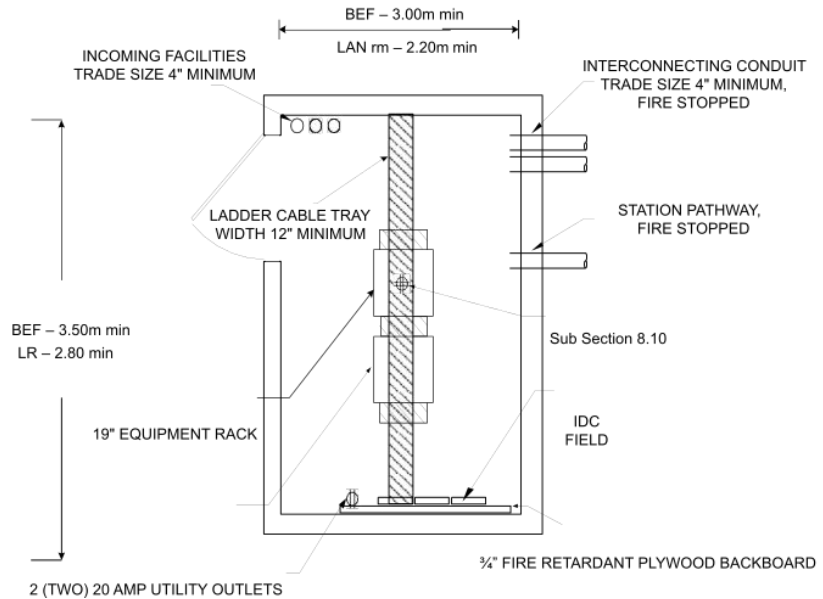
The term Building Entrance Facility (BEF) as employed by the University of Toronto is the location at which the intra-building communications backbone cabling meets the inter-building communications cabling.

- 8.1 Minimum recommended BEF room sizing is 3.50 x 3.00 metres for each 1,000 square metres area served. This is a secure, strategically located room for each University building with the following attributes:
- 8.2 The building entrance facility (BEF) shall be constructed with full height walls using steel studs with minimum 5/8-inch, or metric equivalent, drywall.
- 8.3 All walls shall be finished with in a light colour (e.g., light gray). All existing painted surfaces must be freshly painted including cement floors. All surfaces must have one coat of primer, one intermediate and one or more finish coats of latex paint.
- 8.4 Remove any existing carpet from new BEF's and seal the floor with anti-static material (to be approved by a qualified Professional Engineer). Floor finish shall be gray off-white colour.

8.5 If fire rated plywood is not available then the plywood shall be painted with at least two coats of fire-resistant paint.

8.6 A 3/4-inch fire rated plywood backboard is to be securely mounted on top of the new gypsum board wall or existing surface. The exact size and method of installation will be determined by the site conditions.

FIGURE 1. BUILDING ENTRANCE FACILITY / LAN ROOM (NOT TO SCALE)



8.7 Ceiling lights must be provided with a switch located immediately inside the access door to the room. The fixture(s) should deliver a minimum of 500 lux of illumination throughout the room.

8.8 Maintain positive pressure within the BEF with a minimum of one air change per hour. The HVAC shall be provisioned such that the temperature is kept in the range of 18 to 24 Celsius and the humidity is kept between 30 to 55% Relative Humidity. Dust filters must be installed on all inflow air vents or ducts.

8.9 The BEF shall be equipped with a minimum of two standard nineteen-inch (19") 44RU equipment racks securely bolted to the floor. A minimum 1.0m clearance on three sides (including front and back) of the racks shall be maintained. Each rack shall be provisioned with vertical cable management. A minimum twelve-inch (12") wire cable tray or equivalent shall be provided from the BEF wall to the equipment rack. If other elements of the building infrastructure are co-located with the LAN facilities in the BEF, a minimum clearance of 1.0 metre must be maintained from these elements. All installations must conform to applicable Canadian Electrical Code requirements.

8.10 Cable terminations and equipment placement shall be done in conformance with the typical layout illustrated as illustrated in Figure 2 - *Typical Layout of 19" Racks in BEF and TR*, below. Cable terminations shall be terminated and active equipment installed in separate racks, unless otherwise specified by the Project Manager.

8.11 Three (3) separately fused, isolated ground duplex electrical outlets with lock on breakers are to be installed. One to be wall mounted and the other two secured to the

top of the relay racks. Electrical outlets should be 20A, 120V (5-20R) Isolated Ground. Each equipment rack shall be provided with a minimum eight-outlet surge protected power bar horizontally rack-mounted at its bottom. If emergency generator back-up power is available, the BEF shall be connected to it. The receptacles installed should be red.

- 8.12 Grounding and bonding infrastructure meeting ANSI/TIA 607 requirements shall be designed and/or approved by a licensed Professional Engineer. The bonding shall be routed through all LAN rooms and shall terminate on a LAN room grounding bus bar equipped to handle NEMA compliant grounding hardware. All metallic non-current-carrying conductive parts, including equipment racks, shall be appropriately grounded. The main entrance facility/equipment room in each building shall be equipped with a LAN room main grounding bus bar (LRMGB). Each LAN closet shall be provided with a LAN room grounding bus bar (LRGB). The LRMGB shall be connected to the building electrical entrance grounding facility.
- 8.13 Fire rated door painted to match other existing doors or stained and finished where applicable. The door swing shall either be outward or not deemed as usable space.
- 8.14 The door shall be fitted with a lock set that matches existing locking hardware in the building. If matching lock sets are not available, then it is up to the contractor to confirm an acceptable alternative with the Project Manager. The locking cylinders in the lock sets must be compatible with the University of Toronto ITS master locking system. At no time should a lock set be installed that does not allow free exit from a room.

9. LAN ROOMS (REFER TO FIG. 1, 2, 3)

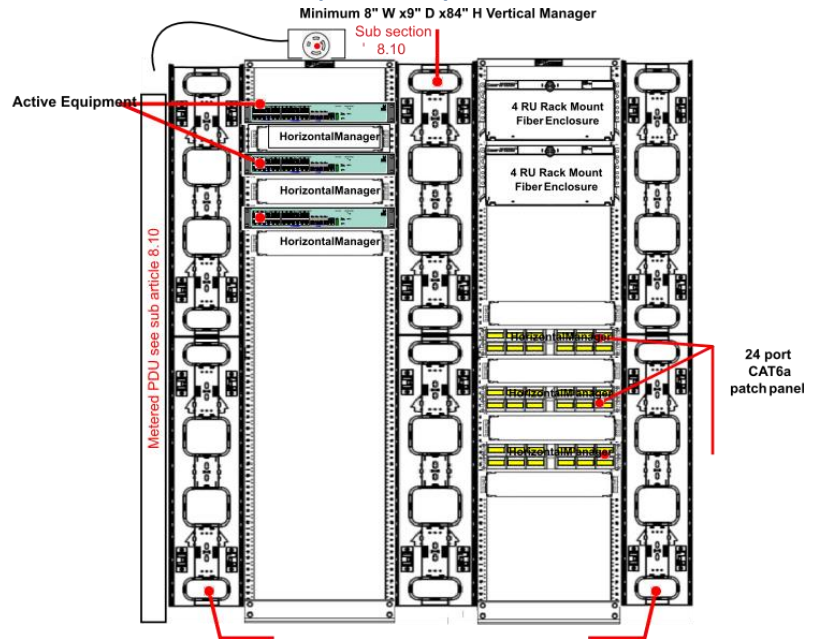
Note: Only approved telecommunications equipment shall be installed in University LAN rooms. Equipment unrelated to network infrastructure and the regular operations of the University networks shall not be installed in LAN rooms. Examples of unapproved equipment include, but are not limited to, the following: building automation devices, security and access controllers, electrical cables and panels, water or waste treatment pipes. Such equipment and facilities shall not be installed without the expressed written approval of the University.

- 9.1 The LAN room shall be located to ensure that UTP CAT6A cable distances to work areas are minimal and do not exceed 90 metres. Where this is not possible, additional LAN rooms on the floor are required. LAN room shall have recommended minimum dimensions of 2.20 m x 2.80 m, as shown in Figure 1.
- 9.2 The LAN rooms shall be constructed with full height walls using steel studs with minimum 5/8-inch drywall. (See Figure 1)

- 9.3 All walls shall be painted to match the existing colour and finish. The use of any other colour must be approved by the owner. All existing painted surfaces must be freshly painted. All surfaces must have one coat of primer, one intermediate, and one or more finish coats of paint.
- 9.4 Remove any existing carpet from new LR's. Seal the floor with anti-static material (to be approved by a qualified Professional Engineer). Floor finish shall be gray off-white colour.
- 9.5 A 3/4-inch fire-rated plywood backboard is to be securely mounted on top of the new gypsum board wall or existing surface. The exact size and method of installation will be determined by the site conditions. (See Figure 1)
- 9.6 Ceiling lights must be provided with a switch located immediately inside the access door to the LAN room. The fixture(s) must deliver at least 500 lux one metre above the finished floor. Provide automatic shutoff lights when LAN room is not in use (motion detector or timer).
- 9.7 Maintain positive pressure within the LR with a minimum of one air change per hour. The HVAC shall be provisioned such that the temperature is kept in the range of 18 to 24 Celsius and the humidity is kept between 30 to 55% Relative Humidity. Dust filters must be installed on all inflow air vents or ducts.
- 9.8 The LAN room shall be equipped with a minimum of one standard nineteen-inch (19") 44RU equipment rack securely bolted to the floor. A minimum 75 cm clearance on three sides (including front and back) of the rack or cluster of racks shall be maintained. Each rack shall be provisioned with vertical cable management. A minimum six-inch (6") wire cable tray or equivalent shall be provided from the TR wall to the equipment rack. (See Figure 1)

9.9 Refer to Typical Layout of 19" Racks in BEF and LAN room for an example of cable termination and active equipment placement in a LAN room equipped with two 19" racks. (See Figure 2)

**FIGURE 2. TYPICAL LAYOUT OF 19" RACKS IN BEF AND LAN ROOM
(44U RACK)**



9.10 Refer to Alternative Layout of 19" Racks in BEF and LAN Room (Figure 3, Photo 1 and 2) for an example of cable termination and active equipment placement in a LAN room. This setup is appropriate for locations where cable management is made difficult or impossible due to space. 1-foot UTP patch cables will be used from patch panel to network device.

FIGURE 3. ALTERNATIVE LAYOUT OF 19" RACKS IN BEF AND LAN ROOM (44U RACK)

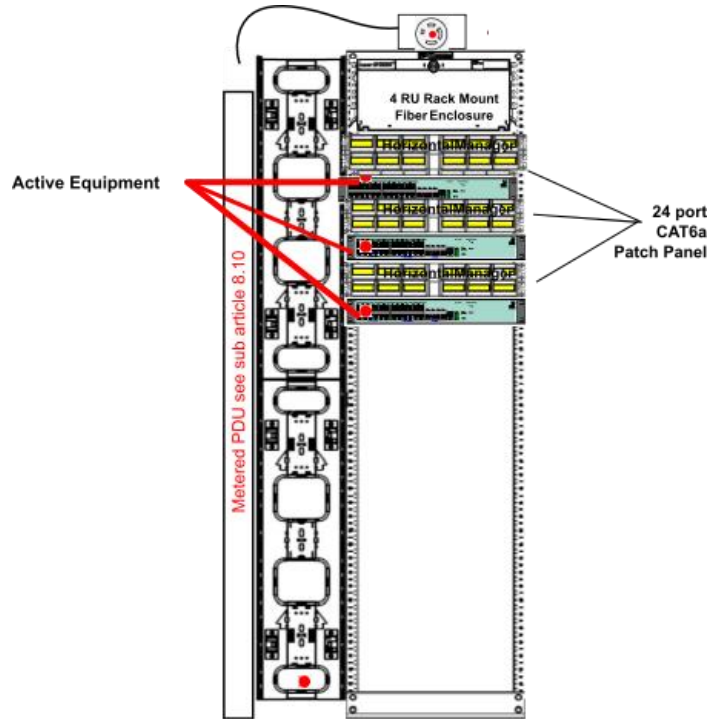


PHOTO 1. TYPICAL LAYOUT OF 19" RACKS IN BEF AND LAN ROOM (44U RACK)

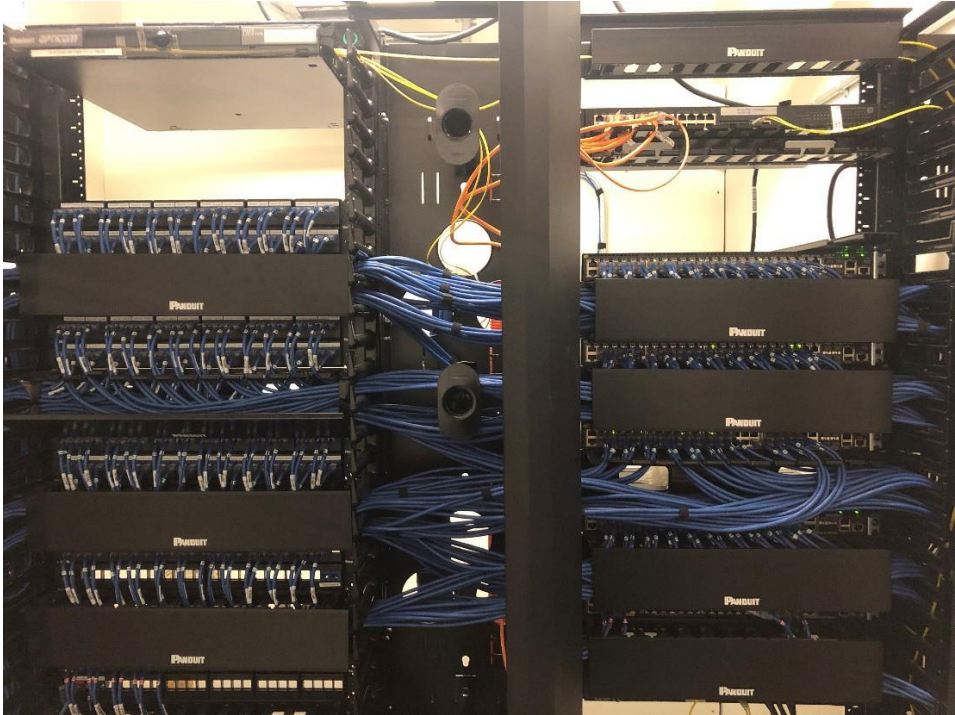
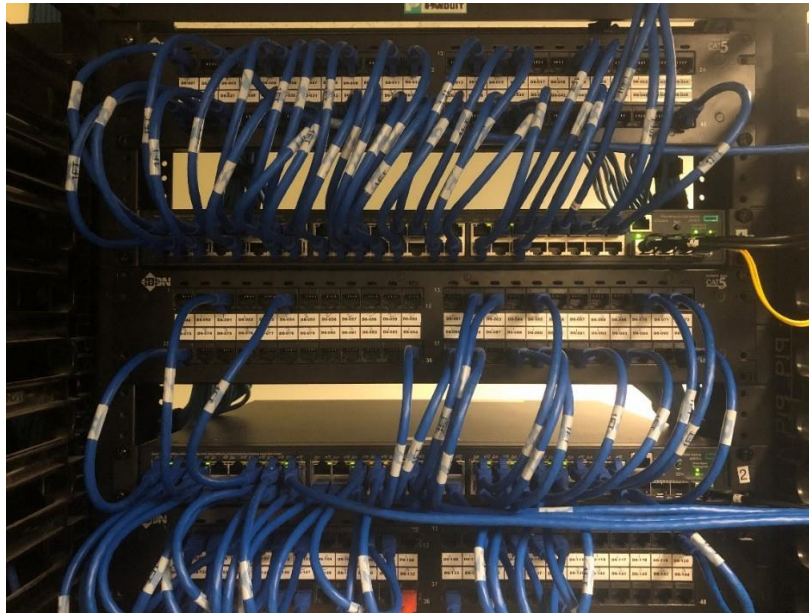


PHOTO 2. ALTERNATIVE LAYOUT OF 19" RACKS IN BEF AND LAN ROOM (44U RACK)



- 9.11 Separately fused, isolated ground duplex electrical outlets with lock on breakers are to be installed. One to be wall mounted and one secured to the top of each of the relay racks. Large equipment racks shall be provided with vertical power bar instead of horizontal for each rack with at least 16 surge protected outlets and rack-mounted on the back of the rack. Smaller equipment racks or wall mounted cabinet or racks shall be provided with a minimum six outlet surge protected power bar horizontally rack-mounted at its bottom.
- 9.12 Electrical outlets should be 20A 208V. Where cumulative power draw is expected to be less than 1500W, the use of 20A 110V outlets is acceptable.
- 9.13 Grounding and bonding infrastructure meeting Canadian Electrical Code and ANSI/TIA 607 requirements shall be routed through all LAN rooms and shall terminate on a LAN room grounding bus bar equipped to handle NEMA compliant grounding hardware. All metallic non-current-carrying conductive parts, including equipment racks, shall be appropriately grounded.
- 9.14 Solid core wood door painted to match other existing doors or stained and finished where applicable. The door shall open outward where permissible and if that is not the

case the swing of the door shall not be counted in the clearances specified for the equipment racks.

- 9.15 The door shall be fitted with a lock set that matches existing locking hardware in the building. If matching lock sets are not available, then it is up to the contractor to confirm an acceptable alternative with the Project Manager. The locking cylinders in the lock sets must be compatible with the University of Toronto ITS master locking system. At no time should a lock set be installed that does not allow free exit from a room.
- 9.16 Painting of UTP/Fibre cables is not permitted. If painting of UTP/Fibre cables occurs, regardless of reason it is presumed damaged. Contractors are liable for replacement and re-installation of damaged cables.
- 9.17 Emergency back-up power is mandatory for LAN/MTR rooms hosting networking equipment for life-critical systems. Example: ATA (analog telephone adapter) for an emergency phone system.

10. ELECTRICAL

General

- 10.1 All electrical work must comply with the latest edition of the Ontario Hydro Safety Code, University of Toronto Electrical Standards, Ontario Building Code, and applicable CSA and ULC Standards.
- 10.2 All electrical works and grounding system installations must be validated by a qualified Professional Electrical Engineer. Where required, Ontario Hydro inspection shall be applied for and paid by the contractor. Installer must provide certificate prior to final acceptance of work.
- 10.3 The use of tandem breakers is not permitted.
- 10.4 All electrical cable must be minimum 12 AWG and installed in minimum 3/4-inch EMT conduit supplied by the contractor and installed directly to the panel location. 12 AWG BX is acceptable only when fishing an existing wall.
- 10.5 The contractor must have a circuit tracer either onsite or readily accessible.
- 10.6 All electrical circuits that have been installed require labeling. The panel end of the circuit will indicate that the circuit is a dedicated ITS circuit and include the room number in which it terminates. The receptacle end of the circuit will indicate the panel number, panel location, and breaker number.
- 10.7 A lockable breaker is required at the panel.

Isolated Ground

- 10.8 The isolated ground (IG) receptacle shall be orange in colour and wired as an individual branch circuit outlet. The outlet will have a separate green or green/yellow wire which runs continuously from the ground conductor terminal to the first panel board where it is connected to the ground bus. Bonding of the conduit boxes, etc., of the circuit is accomplished by ordinary means (conduit or a separate ground wire). The two grounds are connected only at the panel board.
- 10.9 The IG outlet shall be grounded to the same ground as the electrical distribution system. The only difference is that it is connected to ground via a separate wire. There is no 'clean' 'separate' or 'dedicated' ground. The Electrical Safety Code allows only one earthing ground.

11. PATHWAYS

Communications cables shall be contained in pathways installed parallel or perpendicular to building lines unless otherwise specified by the Project Manager. At the point of entry to a building, outside plant communication cables must be plenum-rated CMP (FT-6). The contractor has the choice of running point-to-point riser-rated cable or outside rated cable with a fusion splice near the building entrance to riser-rated cable. When CMP (FT-6) rated cable is specified it shall be supported by J-hooks and/or cable tray when not run-in conduit.

Interference Drawings

- 11.1 When requested by the Project Manager, interference drawings must be submitted prior to commencing with the installation of conduits. These drawings must indicate the conduit routing and pull box locations with reference measurements from two walls or permanent fixtures. Include construction notes describing elevation changes, wall penetrations, and information related to existing fixtures that may be affected by the installation of the conduit. Neatly hand drawn routing and notes on the floor plans provided with the tender are acceptable.

Conduits

- 11.2 All conduits shall be EMT electrical metal tube type installed with steel, set-screw type fittings except on the exterior of the building which shall be rigid galvanized steel with

threaded connectors. Conduit shall be installed in compliance to prevailing codes and standards. Conduits must be installed at right angles and parallel to building grids.

- 11.3 Pull strings must be supplied in all new and reworked conduit.
- 11.4 Pull elbows or LBs are not allowed. Only sweep or 90-degree elbows shall be utilized and no more than 180 degree of bends will be permitted between pull boxes (example: two 45 degree bends plus one 90 degree bend). The minimum radius of curvature shall be 10 times the conduit internal diameter (ID).
- 11.5 In LAN rooms the conduit shall be installed parallel to the backboard with a 90-degree bend toward the floor or enter within 10 inches of and parallel to the cable tray.
- 11.6 All conduit ends shall be fitted with plastic bushings.
- 11.7 All exposed conduit and junction boxes will be painted to match the existing environment. All conduits and pull boxes must be treated and cleaned prior to painting. The conduit must have one coat of primer paint, one intermediate coat, and one or more finish coats of paint. Any colour other than the existing environment must be approved by the owner prior to use.
- 11.8 Maximum distance of conduit run between two pull boxes shall be 30 metres. The pull box shall have a screw type cover not hinged. All pull boxes shall be accessible with a minimum 24 x 24-inch hinged access hatch provided where required. Pull boxes for vertical conduits must be installed to provide a straight pass through for vertical cables. The sizes of junction boxes shall be 8 times the size of the inside diameter size of the conduit entering it. The exception is when 4-inch conduit is used, and then 30x24x6 inch junction boxes are acceptable. Pull boxes are not to be installed in elevator machine rooms. Conduits installed in elevator machine rooms must provide clearance and must not restrict the service area.
- 11.9 When conduit is installed in utility closets the conduit must be installed in a steel sleeve that is 6 inches high and the gap between the floor and the sleeve must be watertight.
- 11.10 All wall and floor penetrations shall be filled with a fire stop rated as per code and finished to match the existing fire stop surface.

Flexible Conduit or Innerduct Tubing

- 11.11 INNERDUCT shall not be used unless specified in the detailed scope of work.
- 11.12 If tubing is specified the inside surface must have a smooth finish that will allow cable to be easily fished.

- 11.13 Tubing must resist crushing pressures and must not collapse within normal bending limits.
- 11.14 It should have an internal diameter of not less than 1 inch.
- 11.15 If tubing is used, the contractor must supply the tubing manufacturer's specifications with the tender response.
- 11.16 Tubing may be specified wherever fibre cable may be subjected to bending forces that would place it at risk of damage.
- 11.17 Tubing may be specified in transitions when in and out of conduit pathways do not line up.
- 11.18 Tubing may be specified in LAN rooms when cable needs to be installed in free air when other support structures are not feasible.
- 11.19 Tubing will not be used to overcome problems induced through bad installation practices of other components.
- 11.20 Fastening of ends of tubing to conduit, racks, or tray to be through mechanically sound fittings, not plastic tie wraps.

Cable Tray

- 11.21 Cable tray specified for LAN rooms shall be wire cable tray or equivalent, no less than 6 inches wide in LAN room and 12 inches wide in BEF by 3.5 inches deep. Only fittings such as sweeping 30, 45, 60, and 90 degree elbows, tees and crosses manufactured by the OEM are to be used to change direction. Use fittings of the smallest available bending radius and still accommodate the bending radius of the backbone cabling. Butting two sections of tray together to create right angle turns is not acceptable. Any custom alterations to the tray must be approved by the Project Manager prior to installation.
- 11.22 When tray is running parallel to backboards install it 4 inches off the backboard to allow passage of cables between the tray and the backboard.
- 11.23 When the tray is adjacent to a wall use right angle brackets or UNISTRUT to support it.
- 11.24 When the tray it is installed in free air to cross a closet, suspend it from the ceiling using threaded rod.
- 11.25 When tray is installed above a relay rack use threaded rod to support the tray 12 inches from the top of the rack where possible.

12. INTER-BUILDING CABLE AND HARDWARE

Inter-building cables are copper and fibre optic cables that provide connectivity between buildings. Three major categories of inter-building cables are defined on campus: main trunk cables (typically between core router locations); branch cables (from a router location to major cross-connects covering a significant area); and, local cables (between building one of each is either small or the last on a cableway). Unless otherwise specified, the following shall apply:

- 12.1 Inter-building cables are OS2 single mode fibre optic and multi-pair Cat3 UTP copper cables.
- 12.2 The use of legacy multimode (OM1 and OM3) fibre cable is permitted for integration into existing legacy fibre infrastructures. If required, the specific type of cable will be specified in the project Scope of Work.

Backbone cables

- 12.3 Backbone cables are installed between major facilities hosting Core layer network devices. Cabling shall be indoor/outdoor loose tube, dry water block fibre cable consisting of, at minimum, 96 single-mode fibres in a water resistant, armoured jacket. Cables shall be installed in a minimum 4-inch (100 mm) duct between buildings.

Branch cables

- 12.4 Branch cables connect major IT facilities to buildings hosting Distribution layer network devices. Cabling shall be indoor/outdoor loose tube, dry water block fibre cable consisting of, at minimum, 48 single-mode fibres in a water resistant, armoured jacket. Cables shall be installed in a minimum 4-inch (100 mm) duct between buildings.

Access cables

- 12.5 Access cables are installed to connect Distribution layer facilities to Access layer facilities (typically smaller standalone buildings).
- 12.6 Cabling shall be indoor/outdoor loose tube, dry water block fibre cable consisting of at least 24 single-mode fibres in a water resistant, armoured jacket. Cables shall be installed in a minimum 4-inch (100 mm) duct between buildings.

- 12.7 A 25-pair EIA/TIA Cat3 UTP cable in a water resistant, armoured jacket shall be installed between buildings. unless otherwise specified by the project scope of work or the Project Manager. Sharing of the 4-inch duct with the fibre cables is acceptable.

Installation Notes

- 12.8 All cables will be installed with 10-foot (~3 metre) service coils at all termination points and transition closets. Service loops may be stored on backboards, in unoccupied sections of cable tray or in conduit pull boxes. Do not store service loops in the fibre cable in the connector tray.
- 12.9 The contractor is responsible for the location of buried utilities, where applicable. These arrangements will be made in advance prior to commencement of work. The contractor is also responsible for the restoration of the area under construction to its original condition or better.
- 12.10 Where landscape property has been disturbed, the contractor must account for the restoration of grass, plants, walkways, etc.

13. INTRA-BUILDING CABLE AND HARDWARE

Intra-building backbone cables are the copper and fibre optic cables that run between the BEF and the LAN rooms within a building.

- 13.1 As a minimum, the building backbone infrastructure should consist of at least 12 strands single-mode cable between each LAN room and the BEF. Multimode and/or UTP CAT6A cabling can be added if requested.
- 13.2 Nineteen-inch relay racks with 77 inches of usable space (44RU) bolted to the floor shall be installed in each LAN room. Rack layouts will include:
- a) One 2RU horizontal cable management bracket for every two 24 port fibre or copper patch panels (or one 48 port). Likewise, 2RU horizontal management shall be provisioned for active equipment residing in the rack.
 - b) One power bar (with internal breaker) mounted switch to the front and outlets on rear utilizing only one rack space.
 - c) A minimum 6-inch vertical cable management with cable bend control mounted to the side of the rack.

- d) A minimum 6-inch-wide wire cable tray or equivalent with 8 inches spacing between rungs to support cables from the LR entry point to the termination locations.
- 13.4 All backbone copper and fibre inter-building and intra-building cables will be installed with 10-foot (3 metre) service coils installed at all termination points and transition closets. The service loops may be stored on the backboard, in an inactive section of cable tray or in the conduit pull box.
- 13.5 Pull string/rope shall remain in all conduits upon completion of cable installation. Backbone and horizontal cable may co-exist in the same conduit. However, all fibre cable must be in separate conduit from the copper type where two conduit paths have been installed.

14. HORIZONTAL CABLING AND HARDWARE

- 14.1 The horizontal distribution cable is the copper or fibre optic cable that runs between the workstation outlet and the rack-mounted patch panel in the LAN room.
- 14.2 Unless otherwise specified, at least two (2) blue jacketed CAT6A TP four-pair cable shall be installed from the rack-mounted modular patch panel in the LAN rooms through the horizontal conduit infrastructure to the outlet location. Where specified, the fibre cable shall be at least 6 (six) strand singlemode cable.
- 14.3 Drop cables may share the riser conduits when installation occurs between floors. When there is a choice, these drop cables should always be installed in the riser conduit that accommodates the corresponding media type (copper with copper, fibre with fibre).
- 14.4 Properly sized conduit should be used between the junction boxes on the horizontal distribution conduits and the user outlet boxes. In many cases the conduit will be surface run-down walls to a surface mount outlet box designed to accept a flush mounted modular faceplate installed on the box.
- 14.5 Wiremold use is acceptable in lieu of EMT conduits where aesthetics are a concern (e.g., historic buildings). Extents of wiremold use should be limited to the necessary minimum.
- 14.6 The use of FT6 fire-rated plenum cable in plenum spaces of buildings is permitted.
- 14.7 RJ-45, 8-position jack modules shall be installed and configured to the EIA/TIA 568A standard as required in the modular faceplate. Blanks shall be used to cover unused spaces in the face plate.

- 14.8 Project specifications may require colour coded jack modules, e.g., orange for wireless.

15. OUTLET PLACEMENT

- 15.1 Standard outlet height when boxes are installed on a wall is 12 inches from the floor.
- 15.2 Conduit or boxes are not to obstruct the function of any adjacent fixtures.
- 15.3 When outlets are mounted on the floor the outlet box should be mounted on its widest surface so that the faceplate is on the side of the box and the cover plate is able to be opened.
- 15.4 Installations involving architectural details, such as elaborate baseboards or outlets mounted at counter level in labs, should be reviewed by the contractor with the Project Manager prior to installing the outlet box if not specified in the detailed scope of work.
- 15.5 The University reserves the right to relocate any LAN outlet by up to 3.0 metres without penalty before installation is complete.

16. WIRELESS SPECIFICATIONS

Wireless AP locations

- 16.1 For each new wireless installation on campus a predictive wireless site survey shall be performed, and results (WAP layout) incorporated with project documentation at the planning stage.
- 16.2 Wireless site survey is performed either by the Information Technology Services (ITS) or by a certified external contractor approved by ITS.
- 16.3 For lengthy capital projects some revisions of WAP layout should be expected at the final stage of wireless implementation to accommodate revisions in floor plans, and technology and industry standards changes.

Wireless design guidelines

- 16.4 To provide pervasive wireless coverage in a building, wireless design shall provide the minimum of negative 65 dBm wireless signal in both 2.4 GHz and the 5 GHz bands.
- 16.5 Wireless design shall specify where WAPs are to be installed and type of mount to be used (wall or ceiling mount).

- 16.6 The model of AP specified must be appropriate to handle the anticipated density requirements of the area being served. Multiple WAPs are typically specified for areas with more than 40- 50 anticipated users.
- 16.7 The design must provide solutions for any potential signal interference or obstruction issues.
- 16.8 Unless otherwise indicated, outdoor WAP's must have wall mounted Lightning Arresters installed in the associated LAN room with the CAT6A cable from the outdoor AP connected into the Lightning Arrester and from there to the patch panel. Where not practical or feasible to install the Lightning Arrester near the patch panel, the Lightning Arrester can be installed near the outdoor WAP. The approved Lightning Arrester is L-Com Model: HGLN-CAT6AJ. Any substitution of equipment will be proposed by the contractor and approved by the University's Project Manager. Contractors will work with the University's Project Manager or delegate to determine the specific mounting methods and location.
- 16.9 Grounding of outdoor AP's will be in accordance with the Canadian Electrical Code CSA C22.1 conforming to sections 10 Grounding and Bonding and to section 60 Electrical Communications Systems or to the Ontario Electrical Safety Code 28th edition. Typical WAP's and Lightning Arresters grounding is continuous stranded green coded wire at AWG #8 - depending on the size of the equipment ground lugs and/or associated electrical ground terminal screws.

Data cabling for wireless APs

- 16.10 The cabling from the LAN room to the wireless data outlet shall be two CAT6A UTP four pair cables. All cables shall be fully contained in new conduit, new raceway and/or the existing building communication pathways that are suitable and conform to Section 14 of this document.
- 16.11 Terminations at the LAN room shall be in rack-mounted patch panels equipped with orange coloured, 8-pin modular jacks and configured to the TIA 568A standard.
- 16.12 New data outlets for the WAPs should be installed approximately 3 metres above the floor level. WAPs shall be mounted on the wall adjacent to the corresponding data outlets. WAPs must not be mounted in locations where the coverage of the WAP is shadowed by HVAC, vents, or other metal or concrete structures.
- 16.13 For the WAP end surface, mount boxes for ceiling mount locations, and in flush mount boxes for wall mount locations, shall be used. The boxes shall be equipped with modular faceplates. White coloured, 8-position jack modules shall be installed as required in the

modular faceplate at the WAP end and configured to the EIA/TIA 568A standard. Blanks are to be provisioned for unused spaces in the face plate.

17. UTP CABLE SPECIFICATIONS

- 17.1 All media shall conform to transmission characteristics specified by the ANSI/EIA/TIA-568-C.2 and ANSI/EIA/TIA-568-C.3 standards.
- 17.2 Intra-building copper UTP cabling shall meet or exceed the ANSI/EIA/TIA Category 6a specification.
- 17.3 Inter-building copper UTP cabling shall meet or exceed the ANSI/EIA/TIA Category 3 specification.
- 17.4 For the grounding of copper cable the contractor shall supply and install BIX/Cable output Cover and splice chamber.
- 17.5 The contractor shall supply and install all necessary protector modules 5 pin black.
- 17.6 The contractor shall supply and install ground wire from Terminal Building Ground to the entrance protector- unit accepts #6 - #14 ground wire, ground wire size is dependent on the distance from source.
- 17.7 The contractor shall terminate incoming cable directly onto the circuit protector.
- 17.8 The contractor shall test as per TIA/EIA standards.
- 17.9 CAT6A cabling should be used for all 911 analog phone cables installed on UofT premises.
- 17.10 Limited use of UTP CAT6 or lower cabling is permitted for data circuits with low bitrate (e.g., IoT applications).
- 17.11 Painting of UTP/Fibre cables is not permitted. If painting of UTP/Fibre cables occurs, regardless of reason, it shall be considered damaged. Contractors are liable for re-installation of all damaged cables.

18. UTP PATCH CABLE SPECIFICATIONS

- 18.1 UTP patch cable connecting network switches to UTP patch panels shall be CAT6A, 28 AWG patch cables.

- 18.2 UTP patch cable length is determined by the type of rack layout in the LAN room.
 - 18.2.1 In a Typical Layout (See Fig. 2 Chapter 9), the patch cables should be an appropriate length from patch panel to active equipment.
 - 18.2.2 In an Alternative arrangement (See Figure A and B Chapter 9), to minimize the need for horizontal cable management, the use of 1-foot patch cables is permitted.
- 18.3 Limited use of legacy UTP CAT6 or less cabling is permitted for data circuits with low bitrate (e.g., IoT applications).

19. FIBRE CABLE SPECIFICATIONS

- 19.1 All inter-building cable must be single mode (OS2) indoor/outdoor loose tube, dry water block, armoured cables with a watertight jacket and central strength member.
- 19.2 With approval, Multi-Mode cable (OM1) may be permitted on horizontal runs within a building to support and/or maintain existing infrastructure.

20. COMPONENT INSTALLATION

- 20.1 All cable and components must be installed as per the manufacturer's specifications.
- 20.2 Connectors should be LC type, ceramic ferrule: physical contact finish with no aluminum construction. The attenuation shall be 0.2 dB typical to 0.4 dB maximum.
For new installations, only fusion splice terminations are accepted. This is to be done in conjunction with manufactured pigtail assemblies with LC connectors. Field termination of connectors is not permitted. Mechanical splice methods are not permitted.
- 20.3 Fusion splicing using pigtails may be permitted to repair defective legacy equipment and/or when adding panels to an existing enclosure.
- 20.4 Lubrication: if cable pulling lubricant is used for Fibre optic cable installations, the contractor must provide in writing the manufacturer and product specification sheet. The contractor is responsible for ensuring the lubrication product is suitable for the installation application.

21. 'AS BUILT' DOCUMENTATION

The contractor must supply complete and accurate documentation for the completed installation. It must include the following information:

- a) All pull box locations referenced to building co-ordinates.
- b) All outlet locations referenced to building co-ordinates.
- c) Conduit routing relative to building co-ordinates.
- d) Pull box and conduit sizes.
- e) Labeling details of all infrastructure components.

When referencing building co-ordinates use the distance between two walls or permanent fixtures.

The project will not receive final acceptance without complete documentation. The minimum documentation to be supplied is "as built" on the tender drawings with the required information. The preferred method is that the contractor supply "as built" documentation in soft copy DXF or (.dwg) format using industry recognized layering conventions and accompanied by two D-size hard copies.

22. TESTING AND WARRANTY

- 22.1 The following copper and fibre optic tests must be satisfactorily performed with the specified documentation provided prior to project sign-off. All test results will be delivered in a machine-readable form compatible with Microsoft Windows. The information shall be formatted as a CSV (Comma Separated Values) flat file. Other formats may be approved by formal request and approval.
- 22.2 Submit to the University the fibre test tool calibration certificate.
- 22.3 Contractors must be certified by the cable manufacturer to provide a 25-year parts and installation warranty from the manufacturer. The contractor is to ensure that all manufacturer registration and compliance regulations are met based on their product selection.
- 22.4 If parts for installation is not covered by a manufacturer's warranty, then the cabling contractor must provide the owner a minimum one (1) year materials and labour warranty.

Copper - 4 Pair

- 22.4 Provide full testing and documentation to satisfy Cat 6A specifications. Tests will be performed from the horizontal cable patch panel in the LAN room to the faceplate jack for all drop cables.

Copper - 25 Pair

- 22.5 Provide full testing and documentation to satisfy all specifications appropriate to the grade of cable installed. Tests will be performed from IDC connector strip to IDC connector strip for each four pairs.
- 22.6 All copper 4- and 25-pair tests will be performed by installers using certification field testers verifying that the cabling system meets the transmission performance requirements as specified in TIA/EIA.

The test results will be documented including the following information:

- a) Cable ID
- b) U of T building number
- c) Tx location
- d) Rx location
- e) Test equipment; Tx type and Rx type
- f) Contractor name
- g) Technician name and signature
- h) Date test performed
- i) Relevant additional comments

Fibre (singlemode)

- 22.7 Bi-directional attenuation tests 1310 nm and 1550 nm for single mode fibre operating wavelengths must be performed on all fibre strands. The test results must be provided with the following information:
- a) Cable ID
 - b) U of T building number
 - c) Attenuation values

- d) Tx location
- e) Rx location
- f) Wavelength
- g) Fibre type
- h) Connector type
- i) Test equipment; Tx type and Rx type
- j) Reference setting at first wavelength
- k) Reference setting at second wavelength
- l) Contractor name
- m) Technician name and signature
- n) Date test performed
- o) Relevant additional comments
- p) Soft copy test results must be supplied in a text file form

23. LABELING

23.1 Labeling shall, in general conform to the AINSI/TIA/EIA-606 standard. The following details the practices to be used at University of Toronto.

Drawing Identifiers

23.2 The legend on all drawings to show building and floor number. All drawings to be referenced as Data Plans

23.3 Each drawing will be prefixed with *DPbbbbff* - where *bbbb* is the building number, *ff* is the floor number

Example: DP012302

Building Identifiers

23.4 All of University of Toronto buildings are identified using the following format:

23.5 2A three-digit number preceded by either a 0 or A.

Example: 0123 or A123

23.6 The Building ID exists in the legend, in the title block and the file name.

Floor Identifiers

23.7 All floors in U of T buildings to be identified by two digits:

01...99 Floors above ground, including ground

GR Ground floor when not identified as Floor 1

1B 1st Basement (where there is only one basement it will be referred to as 1st basement)

2B 2nd Basement

3B 3rd Basement

MZ Mezzanine

LAN Rooms

23.8 All LAN rooms to be identified as **LR xxxx-yyz** - where LR is LAN room, xxxx is the building identifier, yy is the floor identifier and z is the closet identifier, unique per floor.

Equipment

23.9 All equipment shall be identified in the format ***type-building-LR-number***.

Example: **F96-0038-01A-03** designates a 96-port fibre patch panel in building number 38 in LAN room A of the first floor and it is the third fibre patch panel there.

23.10 Consult the Project Manager for equipment designations that should be used.

Inter-building Cable Identifiers

23.11 All cable identifiers shall use the format ***building-type-building-number***. Cable numbers shall be sequential starting at 1 and be unique.

Example: **0009C-0032-02** represents the second copper cable originating in building 9 and ending in building 32.

Pull Boxes

- 23.12 Each cable in every pull box along cable paths shall be labelled for easy. Labels shall reflect the cabling standard. For example, inter-building cables inside a pull box shall be labelled *building-type-building-number*.



Typical Photo 3. Cable chamber with labelled cables

Riser Cable Identifiers

23.13 Riser cables shall be identified in the format building-type-LRa-LRz-number.

Example: **0009C-1BA-04A-04** represents a copper cable in building 9 running from LAN room A of the basement to LAN room A of the 4th floor.

Horizontal Cables

23.14 The horizontal cables shall be labeled in the format D-floor#-room#-cable#. The per room cable numbers shall be sequential beginning at 1.

Example: D03-038-2 represents a second data cable to room 038 of the third floor.

Example: D11-099-5 represents a fifth data cable to room 099 of the 11th floor.

23.15 Note: At the University in many buildings the floor is implicit in the room number. Thus, where labeling space is tight (e.g., modular jacks in a UTP patch panel) therefore, the label may be shortened by omitting the explicit floor number to room#-cable#.

Naming Convention for Wireless Access Point

23.16

1. Internal WAP names:

a. A single WAP in a room or area:

building code-room# (or corridor#) e.g. bf-102

b. Two to eight WAPs in a room or area:

building code- room# (or corridor#)-{direction} e.g. bf-215-n

c. More than eight WAPs in a room or area:

building code-room# (or corridor#, or floor)-{serial} e.g. my-150-a; rl-11-d

2. External WAP names:

- a. Three or fewer WAPs in an area:
building code-x-{direction} e.g. ss-x-s
 - b. More than three WAPs in an area:
building code-x-{serial}
3. Notation:
- a. **{direction}** refers to one of eight options: {n, s, e, w, ne, nw, se, sw, m}.
 - b. **{serial}** refers to one of 24 options: {a to z}.
 - c. For the WAPs that use **{serial}** option, the WAPs' names shall be marked on floor plans at the locations where the WAP will be mounted. The floor plans shall be submitted to ITS.

Labeling Convention for Wireless Cable

23.17

Label for the wireless cables used by internal WAPs:

- a. A room or area with a single WAP:
w-room# (or corridor#)-cable# e.g. w-102-1; w-102-2
 - b. A room or area with two to eight WAPs:
w-room# (or corridor#)-{direction}-cable# e.g. w-215-n-1; w-215-n-2
 - c. A room or area with more than eight WAPs:
w-room# (or corridor#, or floor#)-{serial}-cable# e.g. w-150-a-1, w-150-a-2
2. Label for the wireless cables used by external WAPs:
- a. An area with three or fewer WAPs:
w-x-{direction}-cable# e.g. w-x-s-1; w-x-s-2
 - b. An area with more than three WAPs:
w-x-{serial}-cable# e.g. w-x-a-1; w-x-a-2.
3. Notation:
- a. **{direction}** refers to one of eight options: {n, s, e, w, ne, nw, se, sw, m}.

- b. **{serial}** refers to one of 24 options: {a to z}.
- c. **Cable#** numbers may be either 1 or 2.
- d. For cables that use **{serial}** option, the labels shall be marked on floor plans at the location where the corresponding WAPs will be mounted. The floor plans shall be submitted to ITS.

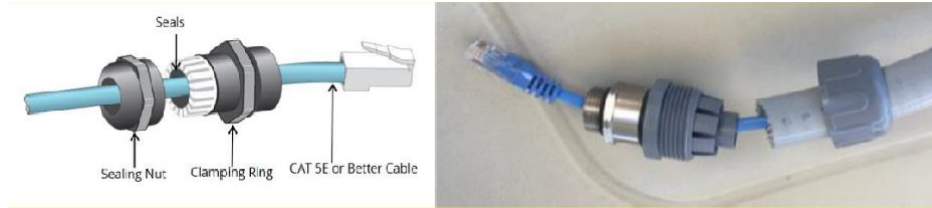
24. Glossary of Terms and Conditions

A	Amps
AC	Alternating Current
AP's – WAP's	Wireless Access Points
AWG	American Wire gauge
BEF	Building Entrance Facility
BX	Metal clad armored cable
CAT6A	Category 6 cable
CMP	Plenum rated cable
CSA	Canadian Standards Association
CSV	Comma Separated Values
DXF	Drawing Exchange Format
EMT	Electrical Metallic Tubing
HVAC	Heating Ventilation and Air Conditioning
IBEW	International Brotherhood of Electrical Workers
IG	Isolated Ground
IT	Information Technology
ITS	Information Technology Services
IoT	Internet of Things
LAN	Local Area Network
LC	Lucent Connector
LRMGB	LAN room grounding bus bar
LR	LAN room
Lux	Illuminance
NEMA	National Electrical Manufacturers Association
OEM	Original Equipment Manufacturer
PM	Project Manager or Property Manager
RU	Rack unit
Rx	Receive
TC	Telecommunications closet

TR	Telecommunications room
Tx	Transmit
ULC	Underwriters Laboratories Canada
V	Volts
W	Watts
WAP	Wireless Access Point
UTP	Unshielded Twisted Pair

Appendix A - Typical Installation of Outdoor WAP's

- Install the outdoor APs at the locations marked on the drawing(s).
- At the AP end use Flex Conduit and M20-to-1/2" NTP adapter to protect Ethernet cables. The conduit and M20-to-1/2" NTP adapter can allow terminated connector through to the AP connector. Refer to the images below.



- The cables shall be terminated in an outdoor waterproof electrical, single gang, junction box to stage connections and glands. Refer to the images below.



Grounding of outdoor AP's will be in accordance with the Canadian Electrical Code CSA C22.1 conforming to sections 10 Grounding and Bonding and to section 60 Electrical Communications Systems or to the Ontario Electrical Safety Code 28th edition. Typical AP's and Lightning Arresters grounding is continuous stranded green coded wire at AWG #8 - depending on the size of the equipment ground lugs and/or associated electrical ground terminal screws.

Unless otherwise indicated or recommended by consultants, outdoor WAP's are required to have Lightning Arresters installed as a wall mount in the associated LAN room. CAT6A cable from the outdoor AP to be connected into the Lightning Arrester and before the patch panel. Where not practical or feasible to install the Lightning Arrester near the patch panel, the Lightning Arrester can be installed near the outdoor AP. Contractors will work with the University's Project Manager or delegate to agree upon the mounting methods and location. The approved Lightning Arrester is L-Com Model: HGLN-CAT6AJ. Any substitution of equipment will be proposed by the contractor and approved by the University's Project Manager.

Outdoor Aruba AP



Fig 1. Images of an Aruba AP 565 and with mounting bracket



Fig 2. Images of an installed Aruba AP 565 with grounding