



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.
- The new recommended standard for UTP cabling is CAT6a instead of CAT6, 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

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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. This document includes specifications for horizontal, intra-building and inter- building wiring some of which may not be part of the scope of work detailed in the specific work order or project tender documents. This document is to 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 further details are provided in the Scope of Work section in the work order or tender specification specific to each project.

2. EMERGENCIES

The successful contractor must advise all of the crew members of the emergency phone number should an emergency arise while on site. 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.

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 & 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 on a daily basis.
- 4.3 The contractor shall protect building equipment, exterior and interior, 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 it is 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 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 https://www.fs.utoronto.ca/wp-content/uploads/2021/05/10_Data_Equipment_Room_Access_Agreement.pdf

7. FIRE DETECTION SYSTEMS

The fire detection systems in the University can be set off by dust. When work is being performed in close 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.

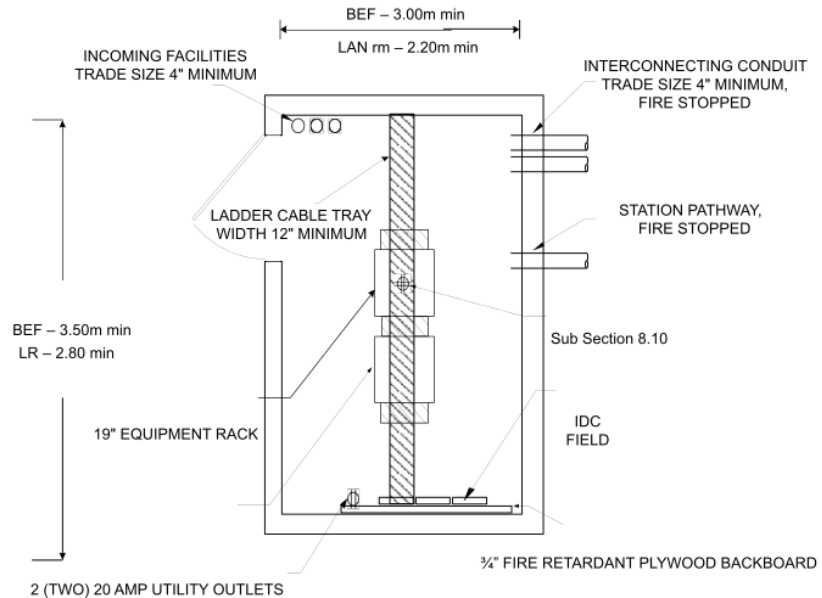
8. BUILDING ENTRANCE FACILITY (REFER TO FIG. 1)

- 8.1 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. Minimum recommended BEF room sizing is 3.50 x 3.00 metres for each 929 square meters 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 metric 5/8-inch 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 should deliver adequate lighting (minimum 500 lux) 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 must be co-located with the LAN facilities in the BEF minimum clearances of 1.0 metre must be maintained and also conform to any applicable Canadian Electrical Code requirements.
- 8.10 Cable terminations and equipment placement shall be in general conformance with the typical layout illustrated below (Typical Layout of 19" Racks in BEF and TR). Cable terminations shall be in one rack and active equipment in another 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.

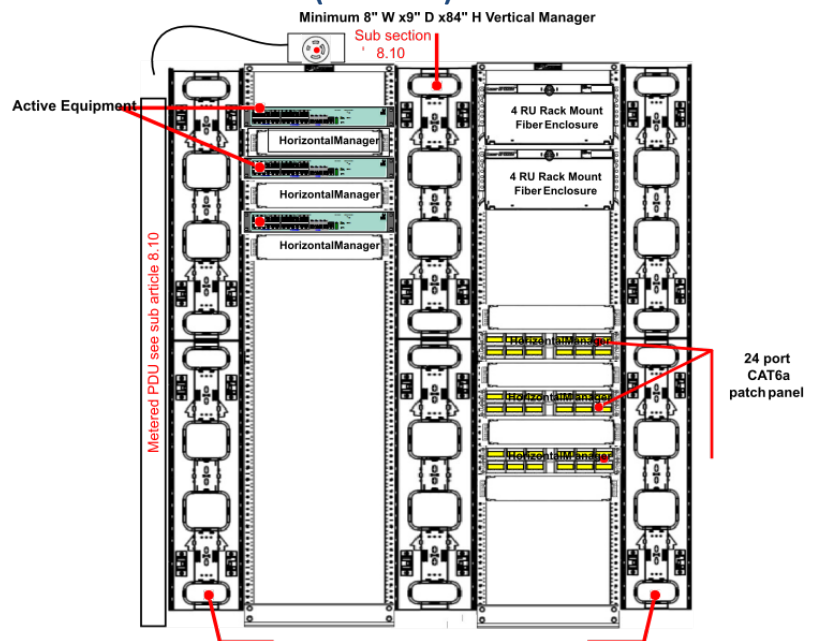
- 8.12 Grounding and bonding infrastructure meeting ANSI/TIA 607 requirements shall be designed and/or approved by a qualified Professional Engineer (P.Eng), licensed (actual or reciprocal) in the province that the work is to be performed. The bonding shall be routed through all LAN rooms and shall terminate 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)

- 9.1 For minimum Building Entrance Facility and LAN room refer to Fig. 1. Additional LAN room per floor is required if UTP CAT6a cable distance to a work area exceeds 55 metres.
- 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 latex or oil-based 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 room. The fixture shall be as a minimum a two-tube fluorescent fixture that delivers at least 500 lux one meter above the finished floor.
- 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)**
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- The diagram illustrates the typical layout of 19-inch racks in a BEF and LAN room, specifically for a 44U rack configuration. It shows a side view of the rack with various components labeled. On the left, there is a section labeled 'Active Equipment'. To its right is a 'Horizontal Manager' section. Further right is a '4 RU Rack Mount Fiber Enclosure' section. A red arrow points from the 'Sub section 8.10' label to the '4 RU Rack Mount Fiber Enclosure' section. Above the rack, there is a label 'Minimum 8" W x9" D x84" H Vertical Manager'. The diagram also shows a 'Sub section 8.10' label with a red arrow pointing to the '4 RU Rack Mount Fiber Enclosure' section.

**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)

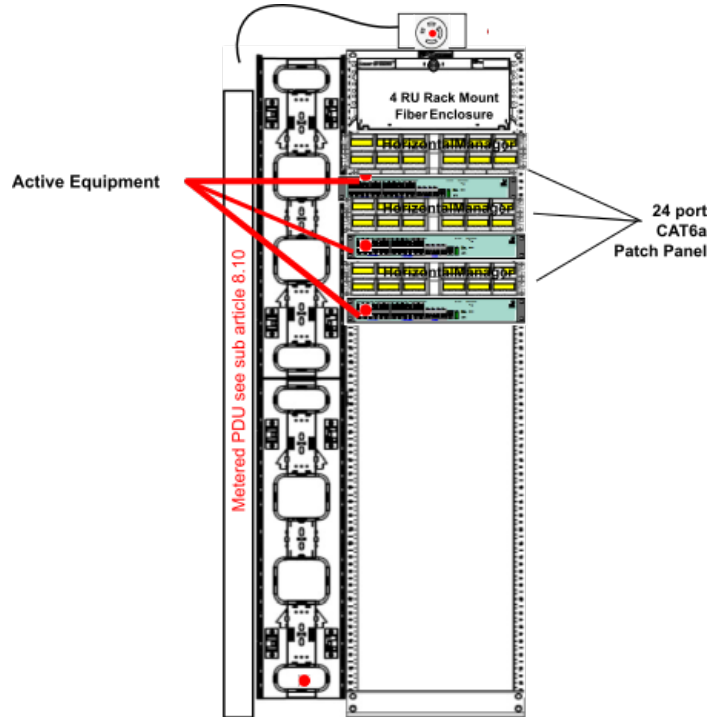


PHOTO 1. TYPICAL LAYOUT OF 19" RACKS IN BEF AND LAN ROOM (44U RACK)

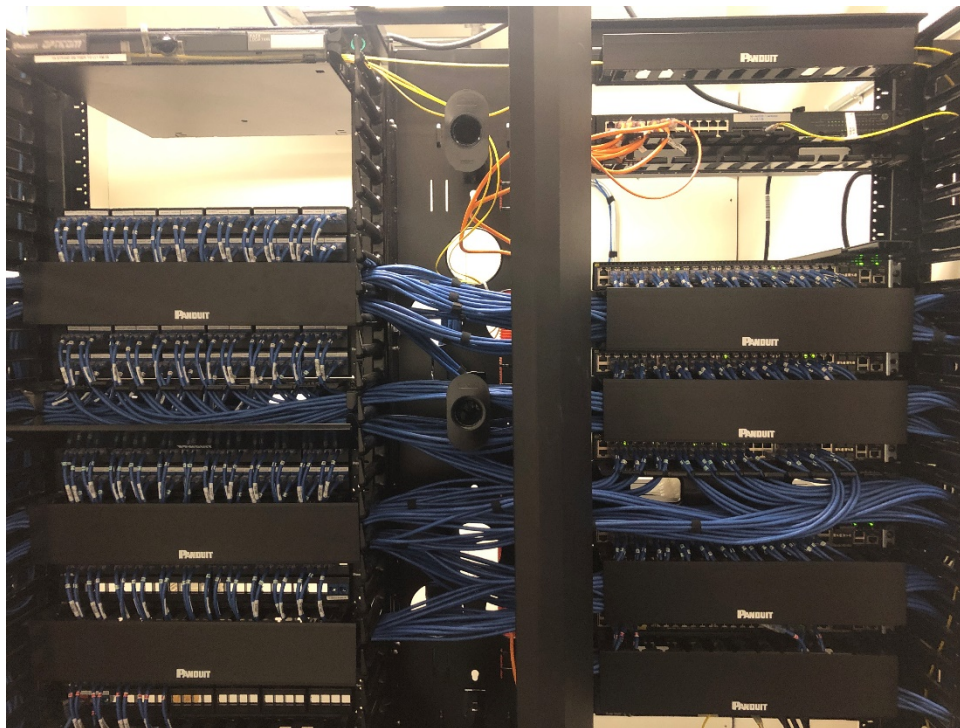
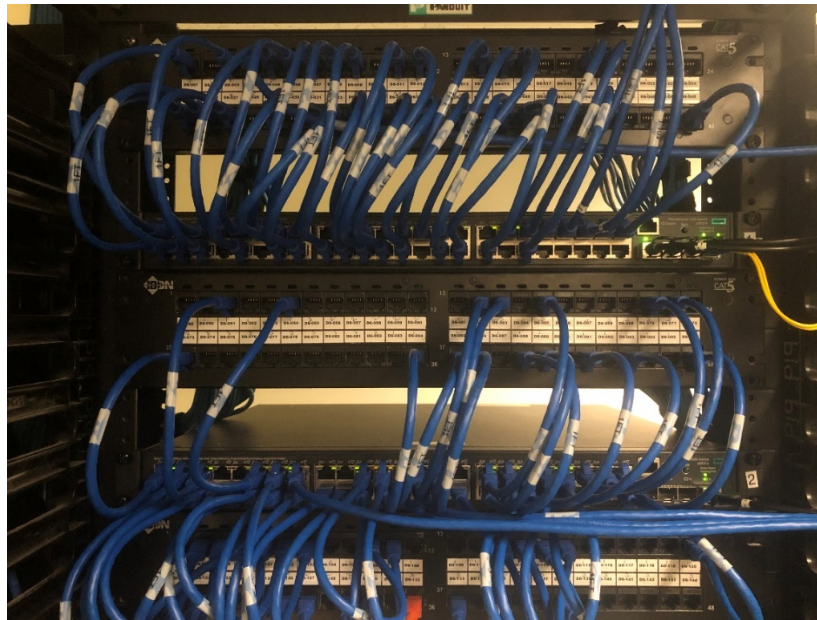


PHOTO 2. ALTERNATIVE LAYOUT OF 19" RACKS IN BEF AND LAN ROOM (44U RACK)



- 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. Each equipment rack 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 under 1500W, 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.

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 and paid for 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 on site or readily accessible.
- 10.6 All electrical circuits that have been installed will also 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 enter in 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 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 with regards 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 in an acceptable format.

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 No pull elbows or LBs will be installed anywhere. Only sweep or 90 degree elbows will 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 maximum 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 is to 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 is not to be used unless it is 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 It 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 The contractor must supply manufacturer's specifications with the tender response if it is specified that details the above requirements.
- 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 land room LR 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 (BETWEEN BUILDINGS)

Unless otherwise specified, the following shall apply:

- 12.1 Inter-building cables are copper and OS2 single mode fibre optic backbone cables that connect building to building. 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)

- 12.2 Limited use of legacy multimode (OM1 and OM3) fibre cables is permitted, with approval, where it is integrated into existing legacy infrastructure.

Backbone cables

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

Branch cables

- 12.4 Branch cables connect major IT facilities to buildings hosting Distribution layer network devices. An indoor/outdoor loose tube, dry water block fibre cable consisting of at least 48 (forty-eight) single mode fibres in a water resistant, armoured jacket shall be installed in a minimum 4-inch 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 An indoor/outdoor loose tube, dry water block fibre cable consisting of at least twenty-four (24) single mode fibres in a water resistant, armoured jacket shall be installed in a minimum 4-inch duct between buildings.
- 12.7 A multi-pair UTP cable in a water resistant, armoured jacket should be installed between buildings (sharing the 4-inch duct with the fibre cables is acceptable). The cable shall be 25 pair EIA/TIA CAT 3 unless otherwise specified by the project scope of work or the Project Manager.

Installation Notes

- 12.8 All cables will be installed with 10-foot (~3 meter) 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 (WITHIN BUILDINGS)

- 13.1 Intra-building backbone cables are the copper and fibre optic cables that run between the BEF and the LAN rooms within a building.
- 13.2 As a minimum, the building backbone infrastructure should consist of at least 12 strands singlemode cable between each LAN room and the BEF. Multimode and/or UTP CAT6a cabling can be added if requested.
- 13.3 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 meter) 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 UTP 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 is a concern (e.g., historic buildings). Extents of wiremold use should be limited to the necessary minimum.
- 14.6 Cable installation in plenum spaces of buildings is allowed (plenum cable fire rated FT6).
- 14.7 RJ-45, 8 position jack modules shall be installed as required in the modular faceplate and configured to the EIA/TIA 568A standard. Blanks are to be provisioned for unused spaces in the face plate. Colour coding of jack modules may be requested if applicable (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 Any architectural detail such as elaborate baseboards or outlets mounted at counter level in labs should be addressed by the contractor prior to installing the outlet box if it is not addressed in the detailed scope of work.
- 15.5 The University reserves the right to relocate any LAN outlet by up to 3.0 meters 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 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 band (IEEE 802.11n) and the 5 GHz band (IEEE 802.11n and 802.11ac).
- 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 design should provide solutions for the areas with high density requirements (more than 40- 50 potential users per WAP)
- 16.7 The design should provide solutions for any potential signal interference or obstruction issues.

Data cabling for wireless APs

- 16.8 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 Chapter 14 of this document.
- 16.9 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.
- 16.10 New data outlets for the APs should be installed approximately 3 meters above the floor level. WAPs shall be mounted on the wall adjacent to the corresponding data outlets. Do NOT mount in spots where AP is shadowed by HVAC, vents, and other metal structures.
- 16.11 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 is presumed damaged. Contractors are liable for replacement and re-installation of damaged (painted) 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), the use of 1 foot patch cables are to be used, minimizing need for horizontal cable management.
- 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. No field termination of connectors will be permitted. No mechanical splice methods will be permitted.

- 20.3 Fusion splicing only 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 specific specification sheet. The contractor must also specify if the product is suitable based on temperature of installation and whether it is for indoor or outdoor application.

21. 'AS BUILT' DOCUMENTATION

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

- 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.
- f) When referencing building co-ordinates use the distance between two walls or permanent fixtures.
- g) 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 machine readable form compatible with Microsoft Windows. The information shall be formatted as a CSV (Comma Separated Values) flat file. Other formats may be provided by formal request and approval.

- 22.2 Submit to the University the fibre test tool calibration certificate.
- 22.3 The installation requires a 25-year warranty from the manufacturer. The contractor is to ensure that all registration and compliance are met based on their product selection.
- 22.4 If the installation is not covered by the 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 CAT 5e specifications (or 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 ANSI/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 DP**bbbbff** - 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 pullbox 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#.

Cables to wireless APs

Cables (**two** to each access point) are labeled in format **W-room#-(position)-cable#**. Based on wireless design and floor layout one of the two labeling schemas can be used (the option is normally indicated in the scope of work).

23.16 Position denotes AP's geographic location in the room (e.g., **n** for north, **sw** for south-west, **c** for centre). Using sequential numbers (see 23.14) in place of positions is permissible. Cable numbers for the same wireless AP to be **1** and **2**.

Example: W-125-w-2 represents the second data cable to AP in room 125, west side.

Example: W-760-ne-1 represents the first data cable to room 760, north-east corner.

23.17 Position denotes AP's location in an irregular room, and sequential alphabetical symbols are used to distinguish each AP. Cable numbers for the same wireless AP to be 1 and 2.

Example: W-237-B-2 represents the second data cable to AP "B" in room 237

Example: W-b87-F-1 represents the first data cable to AP "F" in room b87.

24. Glossary of Terms and Conditions

A	Amps
AC	Alternating Current
AP's - WAP	Wireless Access Points
AWG	American Wire gauge
BEF	Building Entrance Facility
BX	Metal clad armored cable
CAT6	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
UTP	Unshielded Twisted Pair