Design standards: part two
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PART 1 - GENERAL

1.1 NOTES TO DESIGN AUTHORITY

.1 THE FOLLOWING SAMPLE SPECIFICATION IS PROVIDED AS A GUIDE TO LOW SLOPE ROOFING AT THE U OF T ST. GEORGE CAMPUS.

.2 IT IS THE RESPONSIBILITY OF THE DESIGN AUTHORITY ON EACH PROJECT TO INSURE COMPLIANCE WITH LOCAL, PROVINCIAL AND NATIONAL, BUILDING, FIRE AND PLUMBING CODES, ASHRAE REQUIREMENTS FOR THERMAL RESISTANCE AS WELL AS ADHERENCE TO THE CITY OF TORONTO BYLAWS FOR GREEN ROOFS AND LOCAL HERITAGE REQUIREMENTS.

.3 IT IS THE RESPONSIBILITY OF THE DESIGN AUTHORITY ON EACH PROJECT TO PERFORM ALL NECESSARY CALCULATIONS FOR WIND UPLIFT, DRAINAGE, SLOPE TO DRAIN AND FIRE RESISTANCE.

.4 ALTHOUGH A LIGHTWEIGHT INSULATED CONCRETE SYSTEM IS THE PREFERRED SUSTAINABLE ASSEMBLY OF THE U OF T, PROJECT SIZE AND SITE ACCESS MAY REQUIRE THE DESIGN AND INSTALLATION OF A CONVENTIONAL MODIFIED BITUMINOUS ROOF ASSEMBLY. SINGLE PLY ROOF ASSEMBLIES ARE ONLY TO BE CONSIDERED ON ROOFS WITH A MINIMUM OF A 3 IN 12 SLOPE.

1.2 RELATED SECTIONS

.1 Section 01110 – Summary of Work

.2 Section 07620 – Sheet Metal Flashing and Trim

.3 Section 07900 – Sealants

1.3 REFERENCES

The latest edition of all listed references shall apply:


.2 ASTM C726 – Mineral Fibre Roof Insulation Board.


.4 ASTM D41 – Asphalt Primer Used in Roofing, Damp-proofing, and Waterproofing.

.5 ASTM D2822 – Asphalt Roof Cement.


.7 ASTM D6162 – Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fibre Reinforcements

.8 ASTM D6163 – Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fibre Reinforcements

.9 ASTM D6164 – Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements

.10 ASTM D6298 – Fibreglass Reinfored Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheet with a Factory Applied Metal Surface.
1.4 SUBMITTALS

.1 Section 01330 – Submittal Procedures.

.2 Provide initial schedule within five (5) working days after Contract award, showing anticipated progress stages and final completion of work. Work shall not commence before work schedule is provided.

.3 Product Data: Provide characteristics on membrane materials, flashing materials, insulation, vapour retarders, and deck overlay board.

.4 Submit shop drawings for tapered insulation layout to the Consultant for review prior to prefabrication.

.5 Sample copy of Manufacturer's warranty.

.6 Sample copy of Contractor's warranty.

.7 Certifications by manufacturers of roofing and insulating materials that all materials supplied comply with all requirements of the identified ASTM and other industry standards or practices.

.8 Certification from the Contractor that the system specified meets all identified code and insurance requirements as required by the Specification.

.9 Material Safety Data Sheets (MSDS)

1.5 CONTRACTOR QUALIFICATION

.1 Roofing Contractor and his staff must be certified by the membrane manufacturer and pre-approved by the Owner and Consultant prior to tender.

.2 Roofing Contractor must be a member in good standing with the Ontario Roofing Contractors Association (OIRCA) and have a minimum ten (10) years relevant experience with similar roof materials and/or in accordance to a pre-qualified list.
1.6 QUALITY ASSURANCE

.1 Perform Work in accordance with manufacturer's written instructions.

.2 The Contractor shall arrange for a technical representative of the manufacturer to review the installed roof system wherever a Standard or System Warranty has been specified.

.3 There shall be no deviation made from the Project Specification or the approved shop drawings without prior written approval by the Owner, the Owner's Representative, and the manufacturer.

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable local code for roof assembly fire hazard, green and heritage requirements.

.2 UL: Class B Fire Hazard Classification.

.3 FM: Roof Assembly Classification, of Class 1 Construction, minimum wind uplift requirement of I-90, in accordance with FM Construction Bulletin 128. (Design Authority to Calculate Wind Uplift Requirements on Every Project)

1.8 SPECIAL SITE INSTRUCTIONS

.1 NO BITUMEN KETTLES, TORCHES OR OPEN FLAMES ARE ALLOWED ON SITE. ALL ROOF COMPONENTS TO BE MECHANICALLY FASTENED OR ADHERED IN ADHESIVE.

.2 Interior Protection for work to be provided by Contractor.

.3 Minimize disruptions to regular building activities. Noisy Work to be performed outside of regular office/operating hours. Arrange special access and times to project site with Designee.

.4 Staging area to be determined on site with Consultant and Building Owner.

.5 All salvaged copper flashings, cleats, and hook strips from the designated roof replacement areas to be recycled and subsequent value credited to the Building Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 All work to be conducted from the exterior using swing-stage, hoist, etc. If cranes or boom-trucks are required, written approval and permits are required from the U of T prior to arrival of any vehicle used for this purpose.

.2 Site storage is limited. Location of storage to be coordinated with and approved by Owner.

.3 All materials shall be delivered and stored in their original packaging bearing the manufacturers label, grade and product weight, including all other related standards, specifications, and the like.

.4 All materials shall be adequately protected from inclement weather conditions and stored in a dry, well ventilated and weather protected location.

.5 Only materials to be installed on the same day shall be removed from the protected location to the work site.

.6 During extreme temperature, materials shall be stored in a heated location with a 4.4°C minimum temperature and removed only as needed.

.7 Modified bitumen rolls shall be kept clear of all flame and/ or spark's when not being applied directly to the roof structure.
.8 All materials in a rolled configuration shall be stored on end, elevated off the ground on a pallet or skid, to protect the bottom surface from foreign debris and moisture.

.9 When possible, the Contractor should restrict stock piling of material in one location on the roof surface to prevent exceeding the specified deck live load capacity.

.10 Handle and store products in a manner to prevent damage and deterioration.

.11 Remove and replace damaged products at own expense and to the satisfaction of the Consultant.

1.10 ENVIRONMENTAL REQUIREMENTS

.1 Do not apply roofing membrane to damp or frozen deck surfaces.

.2 Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

.3 Only as much of the new roofing as can be made weather-tight each day, including all flashing and detail work, shall be installed. All seams shall be heat welded before leaving the job site that day.

.4 All work shall be scheduled and executed without exposing the interior building areas to the effects of inclement weather. The existing building and its contents shall be protected against all risks.

.5 All new and temporary construction, including equipment and accessories, shall be secured in such a manner as to preclude wind blow-off and subsequent roof or equipment damage.

.6 Uninterrupted water-stops shall be installed at the end of each day's work and shall be completely removed before proceeding with the next day's work. Water-stops shall not emit dangerous or unsafe fumes and shall not remain in contact with the finished roof as the installation progresses. Contaminated membrane shall be replaced at no cost to the Owner.

.7 Arrange work sequence to avoid use of newly constructed roofing as a walking surface or for equipment movement and storage. Where such access is absolutely required, the Contractor shall provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent areas. A substantial protection layer consisting of plywood over felt or plywood over insulation board shall be provided for all new and existing roof areas that receive rooftop traffic during construction.

.8 Prior to and during application, all dirt, debris and dust shall be removed from surfaces by vacuuming, sweeping, blowing with compressed air, and/or similar methods.

.9 The Contractor shall follow all safety regulations as required by OHS (Occupational Health and Safety) and any other applicable authority having jurisdiction.

.10 All roofing, insulation, flashings and metal work removed during construction shall be immediately taken off site to a legal dumping area authorized to receive such materials. Hazardous materials, such as materials containing asbestos, are to be removed and disposed of in strict accordance with applicable Municipal, Provincial, and Federal requirements.

.11 All new roofing waste material (i.e., scrap roof membrane, empty cans of adhesive) shall be immediately removed from the site by the Contractor and properly transported to a legal dumping area authorized to receive such material.

.12 The Contractor shall take precautions that storage and/or application of materials and/or equipment does not overload the roof deck or building structure.
.13 Flammable adhesives and deck primers shall not be stored and not be used in the vicinity of open flames, sparks and excessive heat.

.14 All rooftop contamination that is anticipated or that is occurring shall be reported to the manufacturer to determine the corrective steps to be taken.

.15 The Contractor shall verify that all roof drain lines are functioning correctly (not clogged or blocked) before starting work. Contractor shall report any such blockages in writing to the Owner's Representative for corrective action prior to the installation of the roof system.

.16 The Contractor shall immediately stop work if any unusual or concealed condition is discovered and shall immediately notify Owner of such condition in writing for correction at the Owner's expense.

.17 Site clean-up, including both interior and exterior building areas that have been affected by construction, shall be completed to the Owner's satisfaction.

.18 All landscaped areas damaged by construction activities shall be repaired at no cost to the Owner.

.19 Precautions shall be taken when using adhesives at or near rooftop vents or air intakes. Adhesive odours could enter the building. Coordinate the operation of vents and air intakes in such a manner as to avoid the intake of adhesive odour while ventilating the building. Keep lids on unused cans at all times.

.20 Protective wear shall be worn when using solvents or adhesives or as required by job conditions.

1.11 EXAMINATION

.1 Examine the Drawings and Specifications to determine the extent of the work involved, together with other necessary data affecting the work, as in no circumstances will any claims against the Owner be allowed resulting from failure to ascertain the extent of such work herein described or implied.

1.12 QUALITY OBSERVATION ASSURANCE

.1 An independent Quality Assurance Observation agency, approved by the University of Toronto will be retained to observe the installation. All observations must be performed by either a Registered Roof Observer (RRO) or a Registered Roof Consultant (RRC) as recognized by RCI (The Institute for Roofing, Waterproofing and Building Envelope) employed by an independent Engineering firm licenced in the Province of Ontario. The Engineering firm is required to carry $5 million professional liability (Errors & Omission Insurance). The RRO and/or RRC must possess a certificate for fall arrest protection awareness issued by Canadian Occupational Health & Safety and a CPIC Clearance Certificate.

.2 Arrange site meeting with the Observer no less than three weeks prior to commencement of work on site. Obtain the Observer’s instructions with reference to procedures to be followed. Contractor to provide Observer with the following at this meeting:

1. Notice of Project
2. A sample copy of the Warranty
3. A copy of the letter and completed project warranty form sent to the “Warranty Holder” advising them of the project starting
4. Bonds and Insurance in the Owner’s Name
5. WSIB Clearance Certificate
6. A Contact List complete with 24-hour emergency phone numbers
.7 A Work Schedule listing start date, number of working days and manpower for the project shop drawings for tapered insulation, if applicable

.8 A complete Material List

.9 MSDS information pertaining to ALL materials being used on site

.10 The appropriate securement patterns for mechanically fastening of the insulation, if applicable

.11 A list of the “Trained and Carded Membrane Approved Applicators” who will be working on site

.3 Cooperate with the Observer and afford all facilities necessary to permit full QA observation of the work. Act immediately on instructions given by the Observer.

.4 Make cut-outs when required and make good roofing without additional costs to the Owner.

1.13 SAFETY AND PROTECTION

.1 The latest edition of all listed references shall apply:

.1 CAN/CSA S269.2M – Access Scaffolding for Construction Purposes.


1.14 WARRANTY

.1 Contractor shall supply the Owner with a two (2) year Contractor OIRCA Warranty for workmanship. In the event any work related to roofing, flashing, or metal is found to be within the Contractor warranty term, defective or otherwise not in accordance with the Contract Documents, the Contractor shall repair that defect at no cost to the Owner. The Applicator’s warranty obligation shall run directly to the Owner, and a copy shall be sent to the manufacturer.

.2 Contractor shall provide the Owner with a twenty-five (25) year Manufacturer’s Labour, Material and Workmanship NDL (No Dollar Limit) System Warranty.

.3 Owner shall notify both the membrane manufacturer and the Contractor of any leak that occurs during the time period when both warranties are in effect.
PART 2 - PRODUCTS

2.1 GENERAL

.1 Note all membrane materials, membrane flashings and where applicable the insulations and vapour barrier are to be supplied by the same manufacturer meeting manufacturer’s respective material compatibility requirements to achieve the required System Warranty.

.2 Components to be used that are other than those supplied or manufactured by the membrane manufacturer may be submitted for review and acceptance by the membrane manufacturer.

.3 The membrane manufacturer’s acceptance of any other product is only for a determination of compatibility with the products and not for inclusion in the manufacturer’s warranty.

.4 The specifications, installation instructions, limitations, and/or restrictions of the respective manufacturers must be reviewed by the Owner’s Representative for acceptability for the intended use with the membrane manufacturer’s products.

2.2 DECK OVERLAY BOARD

.1 Deck Overlay Boards on Metal and Wood Plank Deck: Board size shall be 4’ x 8’ x 0.5” (1.2m x 2.4m x 13mm), glass mat faced, siliconized gypsum roof board with factory applied primer, Dens-Deck Prime by Georgia-Pacific, Securerock by CGC or approved equivalent.

.2 Overlay Board Fastener: Dekfast or equivalent mechanical fasteners of appropriate length and with plates in a fastening pattern meeting FM standards. Where fasteners are not practical or will be visible on the underside of metal deck, polyurethane adhesive is to be used to adhere the overlay board to the substrate. Acceptable adhesives are; INSTA-STIK Adhesive by Flexible Products Company-Roofing Group (DOW), OlyBond500 Adhesive by OMG Roofing Products, Para-Stik Adhesive by Siplast, Duotack by Soprema or Warranty Provider approved equivalent.

2.3 VAPOUR RETARDER

.1 Base Sheet: Adhesive grade or self adhering modified bitumen, minimum thickness 3.0mm, with minimum 180g/m², random fibre glass mat or non-woven polyester, impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M.

.2 Base Sheet Flashing: Adhesive grade modified bitumen, minimum thickness 3.0mm, with minimum 180g/m², random fibre glass mat or non-woven polyester, impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M.

.3 Vapour Retarder Adhesive: Solvent based adhesive; Brush Grade for horizontal surfaces and Trowel Grade for sloped surfaces.

2.4 (a) LIGHTWEIGHT INSULATED CONCRETE SYSTEM

.1 Insulation Boards: Type I expanded polystyrene, minimum 1” (25mm) in thickness, with thirty 1” (25 mm) diameter holes and thirty slots, or thirty hole-slot combinations per board. Individual boards to no more than 4’ x 4’ (1.2m x 1.2m) in size. Boards to be factory cut and mitred by Plasti-Fab Inc., Everst Supply Inc., Beacon or approved equivalent. Where possible thermal resistance of a minimum of R = 25 is preferred. Where possible, a minimum roof slope of 1% is required.

.2 Portland Cement: Portland cement conforming to Type I, II or III as defined by ASTM C 150.

.3 Vermiculite Aggregate: Vermiculite concrete aggregate conforming to ASTM C 332 with a ratio of 1:3.5 by volume.

.4 Water Purity: Potable water containing no more than 250ppm of free chloride ions or other
2.5 (a) INSULATION SUMPS FOR LIGHTWEIGHT INSULATED CONCRETE SYSTEM

.1 Insulation Sumps: 8’ x 8’ (2.4m x 2.4m) insulation sump with 2’ x 2’ (610mm x 610mm) central flat is to be installed over the prepared substrate. New insulation sumps to run from 2” (51mm) in thickness at the outer edge down to 1” (25mm) at the central flat. Central flat to be 1” (25mm) thick.

.1 The new insulation sumps to be manufactured of rigid mineral wool fibreboard insulation with bitumen saturated and lightly sanded surface meeting the requirements of CAN/CGSB 2.51.31M and ASTM C726. Standard of acceptance is ProtecRSS-X2 Sump by ModulR TS Inc., TopRock DD Plus by Roxul, SopraRock DD Plus by Soprema or approved equivalent.

.2 Filler Insulation: Rigid mineral wool fibre board with appropriate thickness for installation under new insulation sump as required.

. Insulation Sump Adhesive: Low rise polyurethane adhesive; INSTA-STIK Adhesive by Flexible Products Company-Roofing Group (DOW), OlyBond500 Adhesive by OMG Roofing Products, Para-Stik Adhesive by Siplast, Duotack by Soprema or approved equivalent.

2.4 (b) RIGID BOARD INSULATION

.1 Rigid Insulation Type: Tapered, closed-cell polylsocyanurate foam rigid insulation boards, Type II, Class 1 to ASTM C1289, manufactured with HCFC blowing agent (Pentane) bonded to glass fibre reinforced facers on top and bottom surfaces during the manufacturing process:

.1 Approved and listed by Factory Mutual Global wind uplift classification and compressive strength of 20 psi, and meeting FM4470 approval requirements for Class 1 fire as a component in roof deck construction.

.2 Meet the physical property requirements of ASTM C 1289 and CAN/ULC S-704.

.3 Dimensional stability change of less than 2% conforming to ASTM D 2126.

.4 Conformity to CAN/ULC S704 and Can/ULC S770 for Long Term Thermal Resistance in polylsocyanurate insulation.

.5 Acceptable Products:

.1 Atlas ACFoam III polylsocyanurate by Atlas Roofing Corp.,

.2 Paratherm polylsocyanurate by Siplast,

.3 Colgrip polylsocyanurate by Soprema or approved equivalent.

.2 Rigid Insulation Thickness:

.1 Insulation thickness to be in accordance with minimum Ashrae Requirements and U of T requirement of a minimum of R = 25.

.2 Unless otherwise noted on roof plan drawings, tapered insulation to have a slope of 1%; 0.125” (3mm) vertically per linear foot (305mm) horizontally.

.3 Tapered insulation to be factory cut and mitred, and supplied by Accu-plane Enterprises Inc., Beacon Roofing Supply, Everest Supply Inc., Posi-slope Enterprises Inc. or approved equivalent. Submit all shop drawings to Consultant for review prior to prefabrication.

.3 Rigid Insulation Drain Sumps: ...
2.2 Acceptable Products:

.1 Atlas ACFoam III polyisocyanurate by Atlas Roofing Corp.,
.2 Paratherm polyisocyanurate by Siplast,
.3 Colgrip polyisocyanurate by Soprema or approved equivalent.

2.2 Size: 8’ x 8’ (2.4m x 2.4m) tapered down at 2% to a 2’ x 2’ (610mm x 610mm) central flat area. Central flat to be min. 1” (25mm) thick.

.3 Thickness: To suit height of drain sump curb at each drain

2.4 Rigid Insulation Adhesive: Ribbons of one or two component polyurethane foamable adhesive:

.1 INSTA-STIK Adhesive by Flexible Products Company-Roofing Group (DOW),
.2 OlyBond500 Adhesive by OMG Roofing Products,
.3 Para-Stik Adhesive by Siplast,
.4 Duotack by Soprema or approved equivalent.

2.5 (b) COVER BOARD

.1 Cover Board: Board size no larger than 4’x8’ (1.2m x 1.2m), 0.5” thick (13mm):

.1 Glass mat faced, siliconized gypsum roof board with factory applied primer; DensDeck Prime by Georgia-Pacific,
.2 Fibre reinforced, gypsum roof board with homogenous composition; Securock by USG or approved equivalent’

.2 Cover Board Fasteners: Self tapping, epoxy coated carbon steel or solid stainless steel deck screws approved by membrane Manufacturer to meet warranty requirements, complete with securement plates in a fastening pattern meeting FM requirements:

.1 #12 Dekfast Fasteners by Dekfast Product Group,
.2 #14 Soprafix fasteners by Soprema,
.3 Parafast Roofing Fasteners by Siplast or approved equivalent.

.3 Cover Board Adhesive: Ribbons of one or two component polyurethane foamable adhesive:

.5 INSTA-STIK Adhesive by Flexible Products Company-Roofing Group (DOW),
.6 OlyBond500 Adhesive by OMG Roofing Products,
.7 Para-Stik Adhesive by Siplast,
.8 Duotack by Soprema or approved equivalent.

2.6 MEMBRANE & MEMBRANE FLASHING

.1 Venting Base Sheet (lightweight insulated concrete assembly):

.1 Mechanically secured fibreglass, asphalt coated fibreglass base sheet meeting ASTM D4601, Type II; Parabase FS by Siplast, Sopraglass 100 by Soprema or approved equivalent.

.2 Base Sheet:

.1 Adhesive grade modified bitumen, minimum thickness 3.0mm, with minimum 180g/m², random fibre glass mat or non-woven polyester, impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-50M
.3 Base Sheet Flashing:

.1 Self-adhering grade modified bitumen, minimum 3.0mm thick, with random fibre glass mat impregnated and coated with SBS modified bitumen, and coated with self-adhesive bitumen layer and polyolefin release film on bottom surface, and conforming to CGSB 37-GP-56M

OR

.2 Adhesive grade modified bitumen, minimum thickness 3.0mm, with minimum 180g/m², random fibre glass mat or non-woven polyester, impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M

.4 Cap Sheet:

.1 Adhesive grade modified bitumen, minimum thickness 3.6mm, with minimum 250g/m², fibreglass scrim/polyester composite impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M

.5 Cap Sheet Flashing:

.1 Adhesive grade modified bitumen, minimum thickness 3.6mm, with minimum 250g/m², fibreglass scrim/polyester composite impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M

.6 Membrane Primer:

.1 Solvent based primer to prepare surfaces before the installation of membranes; Standard of Acceptance is PA-1125 Primer by Siplast, Elastocol Stick by Soprema or approved equivalent.

.7 Membrane Adhesive:

.1 Solvent based adhesive; Standard of Acceptance is PA-311 adhesive by Siplast or Colply Adhesive Brush for horizontal surfaces and Colply Adhesive Trowel Grade for sloped surfaces by Soprema or approved equivalent.

2.7 LIQUID APPLIED RESIN FLASHING MEMBRANE

.1 Polymethylmethacrylate (PMMA) Primers: as recommended by the membrane manufacturer.

.2 PMMA Roofing Flashing (Soprema):

.1 Resin for flashing applications: a one-component polyurethane/bitumen resin for use in combination with fleece fabric to form a monolithic, reinforced flashing membrane; Alsan Flashing from Soprema or approved equivalent

.2 Fleece for flashing reinforcement: A woven, 100 g/m², polyester fabric reinforcement as supplied by the membrane system manufacturer; Flashing Reinforcement by Soprema or approved equivalent.

.3 PMMA Roofing Flashing (Siplast):

.1 Catalyst: Pro Catalyst by Siplast.

.2 Resin for flashing applications: A flexible, polymethylmethacrylate (PMMA) based resin combined with a thixotropic agent for use in combination with fleece fabric to form a
monolithic, reinforced flashing membrane; Parapro 123 Flashing Resin by Siplast.
.3 Resin for field membrane: A flexible, polymethylmethacrylate (PMMA) based resin for use in combination with fleece fabric to form a monolithic, reinforced roofing membrane; Parapro Roof Resin by Siplast.

.4 Fleece for membrane and flashing reinforcement: A non-woven, 110 g/m², needle-punched polyester fabric reinforcement as supplied by the membrane system manufacturer; Pro Fleece by Siplast.

.5 Clear finish resin: A clear, flexible, polymethylmethacrylate (PMMA) based resin for use as a wearing coat over colored quartz; Pro Clear Finish by Siplast.

.6 Thixotropic agent: A liquid additive used to increase the viscosity of the PMMA-based resin products, allowing the resins to be applied over vertical or sloped substrates; Pro Thixo by Siplast.

.4 Anti-Skid Surfacing:

.1 Ceramic granules: No. 11 grade specification ceramic granules suitable for broadcast into the PMMA based wearing layer; No. 11 Granules by Siplast or approved equivalent from Soprema.

.5 PMMA Accessories:

.1 Cleaning solution/solvent: A clear solvent used to clean and prepare transition areas of in-place catalyzed resin to receive subsequent coats of resin and to clean substrate materials to receive resin; Pro Prep by Siplast or approved equivalent from Soprema.

.2 Tape: A white, flexible, coated cotton cloth tape designed for treatment of insulation panel joints, deck/wall transitions and joints in flashing substrates; Pro Tape by Siplast or approved equivalent from Soprema.

2.8 ROOF ACCESSORIES

.1 Roofing accessories to be manufactured from spun aluminum or copper as required, and complete with removable caps where applicable. All units are to have foamed in place closed cell urethane foam insulation sprayed into the unit at the plant under controlled conditions. Flanges to be primed with rubberized primer. Stand of acceptance is Thaler Metal Industries or approved equivalent.

**Detail Type:**

<table>
<thead>
<tr>
<th>Prefab Unit</th>
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<tbody>
<tr>
<td>New roof drain</td>
</tr>
<tr>
<td>Retro roof drain</td>
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<tr>
<td>Plumbing stack</td>
</tr>
<tr>
<td>Relief vent</td>
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<tr>
<td>“B” Vent or tall cone</td>
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<tr>
<td>Light post support (w/ thru wire)</td>
</tr>
<tr>
<td>Security camera support</td>
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<tr>
<td>Post and rail support (square HSS)</td>
</tr>
<tr>
<td>Guy wire support</td>
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<tr>
<td>Roof access ladder (bolt to base)</td>
</tr>
</tbody>
</table>
### 2.9 FASTENERS AND PLATES

#### 1. Insulation to steel and wood deck:

- **.1** Tru-Fast Ultra Solid Stainless Steel fastener to penetrate substrate by 3/4" (19mm). Plates to be 3" diameter. Tru-Fast Galvalume stress plate.

#### 2. Wood to steel, wood to wood or steel to steel:

- **.1** Tru-Fast Ultra Solid Stainless Steel fastener to penetrate substrate by minimum 3/4" (19mm).

#### 3. Wood/steel to concrete or concrete block:

- **.1** Perma-Grip Tap Grip H.D. Truss Head fastener with Perma-Coat Z3 corrosion protection to penetrate substrate by 1 1/4" (32mm).

- **.2** Tru-Fast Tap Grip H.D. Truss Head fastener with Perma-Coat Z3 corrosion protection to penetrate substrate by 1 1/4" (32mm).

#### 4. Steel/aluminum to aluminum:

- **.1** Tru-Fast DP with Trucote PC-3 corrosion protection fastener c/w EPDM galvanized steel sealing washers to penetrate substrate by 3/4" (19mm).
### Terminating bar for membrane:

- **.1** Extruded aluminum, 0.060" thick x 1" wide x 10' long with 1/4" x 3/8" slotted holes on 8" (203mm) o/c. Acceptable material: TB-120 aluminum termination bar by Tru-Fast.

### Termination bar fastener for wood, steel or aluminum:

- **.1** Tru-Fast Ultra Solid Stainless Steel fastener to penetrate substrate by 3/4" (19mm) c/w EPDM galvanized steel sealing washers or Construction Fasteners Inc. Woodgrip #14 screw complete with Sentri coating on threads, Chromagard colour match head and EPDM washer

### Termination bar fastener for concrete or masonry:

- **.1** Tru-Fast Tap Grip Truss Head fastener with Perma-Coat Z3 corrosion protection to penetrate substrate by 1 1/4" (32mm) c/w EPDM galvanized steel sealing washers.

### Pre-painted metal flashing to steel or wood:

- **.1** Construction Fasteners Inc. Woodgrip #14 screw complete with Sentri coating on threads, Chromagard colour match head and EPDM washer or approved equal. Fastener to penetrate substrate by minimum 3/4".

### Membrane to wood:

Galvanized round top nails with minimum 1" diameter heads to penetrate the substrate a minimum 1 1/4" (32mm).

### Venting Sheet Membrane to Lightweight Concrete:

- **.1** NVS fasteners as manufactured by OMG, Siplast, Soprema or approved equivalent. Specialty fasteners are as specified in the scope of work or as required in drawings.

### All fasteners and plates to meet the requirements of Factory Mutual 4470 Standard for wind uplift and corrosion resistance.
PART 3 - EXECUTION

3.1 WORKMANSHIP

.1 Execute roofing work which is not specifically covered by these Specifications in accordance with applicable standards in Canadian Roofing Contractors Association (CRCA) and the National Roofing Contractors Association Roofing Specification Manual, in accordance with the Canadian Modified Bitumen Manufacturer’s Association’s recommendations, in accordance with the manufacturer’s pre-printed and published specifications and to ULC Design No. S-107, to FM 1-28 and 1.49 criteria, compliance with local fire insurance requirements and/or local building codes, except where specified otherwise.

.2 Do priming for asphalt roofing in accordance with CAN/CGSB 37-GP-15M and as recommended by membrane manufacturer.

.3 Procedures for application of materials should be in accordance with manufacturer’s recommendations; otherwise the Consultant should be notified if any conflict with this Specification arises.

.4 All work shall be carried out in accordance with drawings, specifications and contract documents.

.5 Adhesives or sealants and liquid primers will not be applied until surfaces are dry.

.6 Inspect the underside of roof deck when installing fasteners, where possible, to avoid accidental damage.

.7 While work is in progress, all steps must be taken to safeguard the building from damage due to the elements.

.8 Advise the Consultant of adjustments to specified roofing procedures recommended by the Manufacturer or due to site conditions. Written approval is needed to make any adjustments to the specified procedures.

3.2 EXAMINATION OF SITE CONDITIONS

.1 Inspect existing conditions and substrates upon which work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of work implies acceptance of existing conditions and assuming full responsibility for the finished condition of the work.

Defective work resulting from application to unsatisfactory conditions will be considered the responsibility of those performing the work of this section.

3.3 PREPARATION

.1 Examine all roof decks and site conditions to ensure that they are in satisfactory condition for the commencement of the work of this section.

.2 Examine work of other trades for defects and discrepancies and report them to the owner/consultant in writing. Do not proceed with work until surfaces are satisfactory.

.3 (On Roof Replacement or Alterations) The existing roof system shall be removed including all membranes, insulation, flashings and associated debris to expose the decking ensuring proper and adequate adhesion of the new roof assembly.
4. Once the existing roofing systems are removed, the deck shall be reviewed by the Contractor and Consultant. The entire roof area is to be reviewed in order to satisfy warranty requirements of the manufacturer of the new roof system. The Consultant is to be notified 48 hours prior to testing.

.5 Prior to the removal of any roof components, all existing openings (drains, vents, air intakes, etc.) shall be covered or plugged to prevent any debris or contaminate from entering the building below. All such coverings are to be removed at the end of each working day and reinstalled prior to the next day’s start up.

.6 At areas designated for removal and replacement, the existing roof gravel, projection and perimeter flashings, roof membrane, insulation, vapour retarder, and old appurtenances are to be removed down to the existing structural deck and disposed of to an appropriate site.

.7 All unused and abandoned pitch pockets, vents, curbs, sleepers, projections, etc. are to be removed from the designated areas and disposed of. Obtain verification and authorization from the Owner before removing any suspected unused or abandoned projections. New decking is to be installed as required to close off any openings prior to the installation of the new roofing system.

.8 Disconnect Electrical Services as required.

.9 Disconnect Mechanical Equipment as required.

.10 Ensure that projections and any equipment (electrical conduit, gas lines etc.) are correctly secured to the decking where applicable. If any inadequate securement is found, the Consultant is to be informed and work around that area is to be halted until the situation has been rectified.

.11 Any rooftop equipment requiring disconnection shall be the responsibility of the Contractor in consultation with the owner unless otherwise specified in this document.

.12 Ensure roof drains have been installed at proper elevations relative to finished roof surface in order to allow for sufficient drainage of the roof surface.

.13 Prior to application of vapour retarder, examine deck and ensure any defect of level or construction is correct before proceeding with the work.

.14 Inspect wood blocking, cants and the like. Do not install roofing unless such items are adequately installed to withstand stresses imposed by thermal movement of the roof components.

.15 Apply each part of roofing system when surfaces are free of moisture for successful application. Consult with manufacturer’s printed instructions for successful application.

.16 All details supplied with this scope of work package are acceptable installations. Any deviance from these details must first approved by the Consultant prior to installation.

3.4 PROTECTION

.1 Cover walls and adjacent work where materials are hoisted and used.

.2 Use warning signs and barriers. Maintain in good order until completion of work.

.3 Protect roof from traffic and damage by placing suitable runways over all new membrane work. Comply with precautions deemed necessary by Consultant.

.4 At end of each day’s work, or when stoppage occurs due to inclement weather, provide protection for completed work and materials out of storage.
5. Contractor is to take care as not to damage any previously performed work, any closely located buildings and all grounds in the vicinity during roofing operations. Contractor shall protect against dust infiltration and other such occurrences. Garbage chutes are to be located as to minimize their exposure to the building and its occupants. Protect walls by means of tarpaulins where garbage chutes and hoisting equipment is located. Cover dumpsters and bins.

.6 Only use equipment that will not adversely affect the deck (damage or alter).
.7 Roof access is to be unobstructed. Doorways and fire routes are to be kept clear of any obstacles.
.8 Examine and repair or replace damage caused by work of this contract with materials and finish to match original to Consultant’s approval.
.9 All non-used materials are to be removed and stored at a location that will prevent any damage (moisture, ultraviolet breakdown, etc.).
.10 All materials for the project are to be delivered to the site. Materials are to arrive in undamaged condition with the original manufacturer’s label intact and clearly visible for easy verification of materials to specified materials.
.11 When temperatures fall below 40°F, any materials such as membrane, adhesives and sealants that are affected by cool temperatures are to be stored in heated storage areas.
.12 Protect rolls from flattening by storing on ends on skids.
.13 Moisture sensitive products and exposed building substrates are to be protected with all work being halted during inclement weather including but not limited to rain fall, snow, drizzle, fog and hail.
.14 Protect all openings and safeguard all vents, stacks, and drains from weather and contamination from debris.
.15 Defective work resulting from application of material on unsatisfactory surface will be considered the responsibility of the Contractor.

3.5 CARPENTRY (GC REQUIREMENT FOR NEW CONSTRUCTION & ROOFING CONTRACTOR ON RE-ROOFING)

.1 The minimum height above the finished roof at curb locations and at wall bases is to be 8” (203mm). The minimum height at parapets is to be 6” (152mm) above the finished roof.
.2 (On Roof Replacement or Alterations) Contractors are to add new wood blocking as necessary to maintain minimum heights at perimeters and curbs. Contractor to replace any seriously damaged or deteriorated wood at perimeters and projections with new construction grade spruce wood blocking or exterior grade, good one side plywood to match existing. Determination of the suitability to re-use or replace existing wood to be at the sole discretion of the Consultant.

.1 Ensure existing wood blocking remaining at perimeters and curbs is securely fastened to existing substrate before installing any new blocking.
.3 Contractor to install wood blocking as required to ensure that all curbs and sleepers for H.V.A.C. and mechanical equipment are level.
.4 All new and existing wood blocking and plywood is to be considered part of the roof, and to be made watertight by the end of each working day to eliminate moisture infiltration into the roof system.

.5 All fasteners to be flush or slightly sunk with surface of wood blocking being secured.
.6 As indicated on drawings install blocking and cant strips to accommodate slopes and insulation, roofing, and sheet metal.

.7 Carpentry alterations will be performed to accepted trade practice.

.8 Before proceeding, installation of vapour retarders is to be in place.

.9 Wood to wood, wood to metal, wood to masonry or concrete to be secured at 12” (305mm) on center staggered.

3.6 DECK OVERLAY BOARD (METAL DECK AND WOOD PLANK DECK)

.1 Mechanically fasten or adhere the deck overlay board with plates over metal or wood deck as per manufacturer’s written instructions and meeting FM guidelines.

.2 Install sheets of the deck overlay board with long axis of each sheet perpendicular to the direction of the steel deck flutes.

.3 Butt sheets tightly together with end joints staggered by half the width of one sheet.

.4 Mechanical fasteners to penetrate top flutes only, by no less than ¾” (19mm) and by no more than 1” (25mm).

.5 Polyurethane adhesive is to be applied to manufacturers printed instructions and in accordance with Factory Mutual guidelines.

.6 Check underside of deck before installation to eliminate damaging any existing conditions below the deck.

.7 Cut new deck overlay board as required at perimeters and projections.

.8 Apply appropriate primer to top surface of the deck overlay boards as per manufacturer’s written instructions and allow to dry prior to the installation of the new vapour retarder.

3.7 VAPOUR RETARDER

.1 Install a continuous layer of modified bitumen base sheet and base sheet flashings over prepared substrate.

.2 The substrate must be clean, dry, and free of dust, grease, or other contaminants.

.3 Vapour retarder must be installed on the same day as the primer application. Do not install when rain or snow is present or imminent, or on wet/damp surfaces.

.4 Field Sheet Installation:

.1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and re-roll from both ends.

.2 Apply cold adhesive using notched squeegee at rate recommended by manufacturer. Adhesive to be applied evenly, without skips, voids, or excessive amounts at any location.

.3 Unroll and install base sheet carefully in straight, parallel rows.

.4 Lap sheets 3” (76mm) for side laps and a minimum 6” (152mm) for end laps ensuring that the polyethylene top film is properly hot air welded to form a watertight seal.

.5 Application to be free of blisters, wrinkles and fish-mouthes.
.5 Flashing Installation:

.1 Prime substrate to receive self-adhering base sheet flashing with specified primer at rate recommended by manufacturer. Avoid pools and heavy areas and allow primer to dry a minimum 30 minutes or until staining does not occur to the touch and surface becomes tacky.

.2 Ensure complete coverage of the primer to both prepared substrates and to the field sheet membrane prior to placement of the membrane flashing.

.3 Install membrane flashing onto substrate in 40" (1m) wide strips extending over perimeters as shown on detail drawings.

.4 Unroll and install membrane flashing onto substrate by removing the release paper and discarding.

.5 Using weighted roller as recommended by manufacturer, roll all surfaces of roof membrane to ensure continuous adhesion with membrane to substrate. Firmly press the membrane into the substrate to ensure proper bond.

.6 Lap membrane flashing onto field membrane a minimum 6" (152mm). Side laps between adjacent sheets to be a minimum of 5" (127mm) wide.

.6 Self adhering modified bitumen flashings may be used at perimeters or projections where cold adhesive may be an issue.

.7 All side and end laps of the base sheet and base sheet flashing shall be hot air welded to the satisfaction of the Consultant.

.8 INSTALL MEMBRANE GUSSET REINFORCEMENT AT ALL INSIDE AND OUTSIDE CORNERS.

.9 New vapour retarder to act as a temporary roof membrane providing complete, continuous waterproofing to the roof prior to the wet installation of the new N.V.S insulation system. Contractor to ensure temporary roof membrane is watertight and has sufficient temporary drainage prior to installation of the new N.V.S. insulation system. Water damage caused to building and its contents by roof leaks after this stage will be rectified by Contractor at no expense.

3.8 (a) FLAT LIGHTWEIGHT INSULATED CONCRETE

.1 Install a flat N.V.S. insulation system over the prepared surface. The N.V.S. insulation system is to consist of expanded polystyrene insulation boards and a top pour of light weight insulating concrete. N.V.S. insulation system work must be done by a qualified Installer.

.2 IT IS THE RESPONSIBILITY OF THE N.V.S. CONTRACTOR TO TAKE ALL NECESSARY PRECAUTIONS TO AVOID ACCIDENTALLY CONTAMINATING ADJACENT WALLS AND ROOF AREAS WITH N.V.S. CONCRETE SLURRY. N.V.S. Contractor must clean up all accidental spills immediately and restore the affected areas to original condition at no cost to the Building Owner. All clean-ups must be to the satisfaction of the Consultant AND Owner.

.3 Prior to installing the new expanded polystyrene insulation, a pour of the light weight concrete a minimum of 0.125" (3mm) thick is to be applied to the substrate.
4.3.9 TAPERED N.V.S. INSULATION

.1 Install a tapered N.V.S. insulation system over the prepared surface. The N.V.S. insulation system is to consist of expanded polystyrene insulation boards and a tapered top pour of lightweight insulating concrete. N.V.S. insulation system work must be done by a qualified Installer.

.2 IT IS THE RESPONSIBILITY OF THE N.V.S. CONTRACTOR TO TAKE ALL NECESSARY PRECAUTIONS TO AVOID ACCIDENTALLY CONTAMINATING ADJACENT WALLS AND ROOF AREAS WITH N.V.S. CONCRETE SLURRY. N.V.S. Contractor must clean up all accidental spills immediately and restore the affected areas to original condition at no cost to the Building Owner. All clean-ups must be to the satisfaction of the Consultant.

.3 Prior to installing the new expanded polystyrene insulation, a pour of the lightweight concrete a minimum of 0.125" (3mm) thick is to be applied to the substrate.

.4 Embed a layer of minimum 5" (127mm) N.V.S. insulation boards in a stair step pattern away from the drain into the minimum 0.125" (3mm) layer concrete to create a foundation for the lightweight concrete top pour. The maximum rise between steps in the insulation is to be 1" (25mm).

.5 All boards shall be placed in position and walked in to ensure adequate slurry protrudes through the holes. Do not slide boards into place.

.6 All insulation boards are to be installed in parallel courses with adjacent boards being butted tightly together.

.7 Install the lightweight concrete slurry over top of the insulation boards. The slurry coat is to have a minimum thickness of 1" (25mm) and is to be trowelled to attain a minimum 1% slope; 0.125" (3mm) vertical rise per linear foot (305mm) horizontally.

.8 The N.V.S. insulation to have a minimum thickness of 2" (51mm) at drain locations; 1" (25mm) of Insulperm board and 1" (25mm) of N.V.S. top coat. Install N.V.S. Insulation to achieve a minimum R-value of 25 across each roof.

.9 Trowel the light weight concrete slurry around all projections (curbs, chimneys, sleepers, etc.) wider or longer than 1" (25mm) to form a drainage cricket/saddle.

.10 The slurry top coat is to be allowed to dry completely to attain a minimum fastener pullout resistance of 40 psi prior to the installation of the new venting base sheet. IRC Building Sciences and the manufacturer are to be present during pull-strength tests on each roof area.

.5 Install lightweight concrete slurry over top of the insulation boards. The slurry is to have a minimum thickness of 1.25" (32mm) over the entire surface.

.6 Trowel the light weight concrete slurry around all projections (curbs, chimneys, sleepers, etc.) wider or longer than 1" (25mm) to form a drainage cricket/saddle.

.7 The slurry top coat is to be allowed to dry completely to attain a minimum fastener pullout resistance of 40 psi prior to the installation of the new venting base sheet. IRC Building Sciences and the manufacturer are to be present during pull-strength tests on each roof area.

.8 Prior to the application of the roof membrane system, scrape any ridges, trowel markings or other protrusions, and fill any voids as required to create a smooth surface for the membrane.

.9 Installation of NVS insulation system to be in accordance with the manufacturer’s written guidelines and instructions.
Prior to the application of the roof membrane system, scrape any ridges, trowel markings or other protrusions, and fill any voids as required to create a smooth surface for the membrane.

Installation of NVS insulation system to be in accordance with the manufacturer’s written guidelines and instructions.

3.10 (a) INSULATION SUMPS FOR N.V.S.

.1 Install wood block frame of appropriate height center around each existing drain location to accommodate a new 8' x 8' (2.4 x 2.4m) tapered insulation drainage sump.

.2 Install 1 ply of modified bitumen base sheet flashing overtop of the new wood frame to make watertight.

.3 Drainage sumps shall be fully adhered to the vapour barrier inside wood frame after installation of N.V.S. insulation system.

.4 At all drain locations on the roof replacement areas, a new 8' x 8' (2.4m x 2.4m) insulation sump with 2' x 2' (610mm x 610mm) central flat is to be installed over the prepared substrate.

.5 New insulation sumps to run from 2" (51mm) in thickness at the outer edge down to 1" (25mm) at the central flat. Central flat to be 1" (25mm) thick.

.6 Install new rigid mineral wool fibre board filler of appropriate thickness under new insulation sump as required.

.7 Fully adhere the insulation sump to the vapour retarder in a full bed of adhesive and ensure to achieve proper coverage rate.

3.11 (a) VENTING BASE SHEET (LIGHTWEIGHT INSULATED CONCRETE ASSEMBLY)

.1 Overtop of the tapered N.V.S. insulation system, install a new venting base sheet prior to installation of new modified bitumen membrane.

.2 Venting base sheet shall be laid free of wrinkles, voids or pockets.

.3 Install the venting base sheet along the flat of the roof, turn up at perimeter details, and extend to the outside edge of the perimeter.

.4 The venting base sheet shall be secured by means of N.V.S. compatible mechanical fasteners with a minimum 40 p.s.i. pullout strength.

.5 Mechanically fasten venting base sheet at 9" (229mm) o.c. on all side and end laps, and at 12" (305mm) o.c. in the field.

3.8 (b) RIGID BOARD INSULATION

.1 Overtop of prepared deck overlay board and vapour retarder substrate, install a layer of tapered polyisocyanurate insulation in accordance with tapered insulation layout on roof plan and insulation supplier’s shop drawings.

.2 Do not use warped or curled insulation boards. For uneven surfaces, trimming or slitting of boards may be necessary.

.3 Install insulation boards in parallel rows and with joints staggered by one half board length. Where multiple layers of insulation are installed, stagger all end joints by min. 6" (152mm).
Custom cut insulation boards at perimeters and projections to suit. Install boards tightly together with no gaps between insulation boards larger than 0.125” (3mm).

.5 Fully adhere insulation to vapour retarder using continuous beads of polyurethane foambale roofing adhesive. Follow manufacturer’s installation instructions.

.6 Install continuous, ribbons of polyurethane adhesive in parallel lines to meet FM requirements. Use a “Z” pattern over an application area no larger than 12'-0” (3.66m) at a time. Minimum securement pattern:

.1 Adhesive ribbons to be no less than 1/2” (13mm) to 3/4” (19mm) in width at time of application.

.2 Parallel rows of adhesive ribbons to be no more than 1'-0" (305mm”) apart in field of roof.

.3 Along 10'-0” (3.05m) wide perimeter zones, rows of adhesive to be no more than 6” (127mm) apart.

.4 Rows of adhesive to be no more than 4” (102mm) apart in corner zones.

.7 Do not allow rising foam adhesive to skin-over. Place insulation panels immediately into wet adhesive.

.8 Walk-in board panels to ensure positive adhesion of substrate across full panel. Repeat walk-in every five (5) minutes until insulation is firmly attached.

3.9 (b) COVER BOARD

.1 Install a layer of cover board panels in beads of polyurethane foambale roofing adhesive over rigid insulation as per manufacturer’s written instructions and to meet FM requirements.

.2 Install continuous ribbons of polyurethane adhesive in parallel lines centered over top of deck flutes or ribs to meet FM requirements. Use a “Z” pattern over an application area no larger than 12'-0” (3.66m) at a time to minimum securement pattern:

.1 Adhesive ribbons to be no less than 1/2” (13mm) to 3/4” (19mm) in width at time of application.

.2 Parallel rows of adhesive ribbons to be no more than 1'-0” (305mm”) apart in field of roof.

.3 Along 10'-0” (3.05m) wide perimeter zones, rows of adhesive to be no more than 6” (127mm) apart.

.4 Rows of adhesive to be no more than 4” (102mm) apart in corner zones.

.5 Do not allow rising foam adhesive to skin over. Place roof board panels immediately into wet adhesive.

.6 Install panels in parallel rows and butt tightly together with end joints staggered by a half width of sheet. Stagger panel end joints with joints of rigid insulation below by min. 6” (152mm).

.3 Cut new deck overlay board as required at perimeters and projections.

.4 Walk-in board panels to ensure positive adhesion of substrate across full panel. Repeat walk-in every five (5) minutes until insulation is firmly attached.

3.12 GENERAL MODIFIED BITUMEN INSTALLATION PROCEDURES

The following general procedures shall apply to the modified bitumen membrane installation.
.2 Basic Rules For Application:

.1 Surface Inspection: Modified Bitumen membranes can be applied over wood, metal, gypsum board and concrete decks which must be clean, smooth, and free of snow, ice, moisture, and debris.

.2 Application of Primer: Priming is required for all substrates prior to the installation of a modified bitumen membrane. The primer is to be applied at a rate of approximately ½ gal/100ft² with a roller or sprayer. Contractor is to allow primer to dry prior to adhering membrane to the prepared substrate. Drying time will vary according to the deck and weather conditions.

.3 First Roll Starting Point: Low Slope and Flat Roofs: Base sheet to begin at drain level with the side lap aligned with the centre of the drain, rolls to run perpendicular to the slope (where applicable). Cap sheet to be installed over the base sheet and cover the overlap in the base sheet. Center of cap sheet to align up with centre of the drain.

.4 Alignment of Rolls: The first roll to be completely unrolled and aligned with the edge of the roof. Where required, the membranes are to be unrolled and allowed to relax for the required time. The membrane is to be re-rolled from both ends to the centre, then applied as per specifications.

.5 Staggering of Sheets: End laps between base and cap sheets to be staggered approximately 24” (610mm). Side laps between base and cap sheets are to be offset 12” (305mm). Laps in the membrane (base and cap) are to be 3” (76mm) wide for side laps and 6” (152mm) wide for end laps.

.6 End Lap and Side Lap Sealing at Areas of potential moisture infiltration at voids created by overlapping rolls of membrane:

.7 Procedure to Seal Voids

.1 Prior to installation, the corner of the salvage edge covered by the next roll of material is to be cut off when the membrane is unrolled.

.2 This procedure to be carried out for the application of membranes (base sheets, cap sheets and flashings).

.8 Salvage Edge Protection: Granular along the edge of the membrane to be primed prior to the application of adhesive to provide good adhesion of the laps.

.9 Membrane Flashings:

.1 Base flashings to extend 6” (152mm) onto the base sheet from the bottom of the perimeter detail.

.2 Cap flashings to extend 9” (229mm) onto the cap sheet from the bottom of the perimeter detail.

.10 Seams: Seams in all sheets to be checked with a round nosed trowel while work is in progress. Deficiencies found to be repaired prior to installing the covering layer or leaving the roof area at the end of the day.

.11 Reinforcement: Reinforcement is required at corners, vents and drains, mechanical units, and gravel stops.

.3 Potential Defects/Deficiencies:

.1 Delamination of Materials: The membrane may not be fully bonded to the substrate due
.1 moisture present on the substrate.
.2 dirt, dust or other contaminate on the substrate acting as a parting agent.
.3 inadequate application of primer or adhesive.

.2 Mis-alignment of Rolls: This occurs when the roll of membrane being applied swerves and the alignment to the starting line is lost. This can occur when the roll is not unrolled, aligned and re-rolled straight. When a roll becomes mis-aligned it is to be cut at the point where the swerve begins and restarted.

.3 Wrinkles: Wrinkles are undulations located on the surface of the membrane after it has been applied. Depending on its origin, a wrinkle may have different appearances. With a Fully Adhered System, defects can be:

.1 Cross-Sheet undulations: These appear as wrinkles, but are waves which occur when the membrane is installed in a stop and go fashion.

.2 Continuous Ridging of the Membrane: These wrinkles are formed by movement of the substrate underneath the membrane. The contractor is responsible for ensuring that the substrate is secure prior to installing the membrane.

.4 Blisters: A blister is a pocket of air under the membrane where full adhesion was not attained or trapped moisture was released from the substrate. In isolated areas, no overlap location and low traffic areas, blisters pose any threat to the water tight integrity of the membrane. Large blisters should be removed and repaired. The repair consists of adhering any loose membrane, then applying a patch extending a minimum 6” beyond the cut out area on all sides.

3.13 MEMBRANE INSTALLATION

.1 Install two ply modified bitumen membrane system overtop of prepared substrate. All membrane to be installed as per the manufacturer's written instructions and as per the guidelines below.

.2 MEMBRANE GUSSET REINFORCEMENT TO BE INSTALLED ON TOP OF BASE SHEET MEMBRANE AT ALL INSIDE AND OUTSIDE CORNERS. CONSULTANT TO REVIEW GUSSET INSTALLATION BEFORE INSTALLATION OF CAP SHEET MEMBRANE.

.3 ALL REQUIRED RELIEF VENTS TO BE INSTALLED DURING THE INSTALLATION OF THE BASE SHEET MEMBRANE.

.4 Base Sheet, Cold Adhesive Installation:

.1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and re-roll from both ends.

.2 Apply cold adhesive using notched squeegee at rate recommended by manufacturer. Adhesive to be applied evenly, without skips, voids, or excessive amounts at any location.

.3 Unroll and install base sheet into the prepared substrate and broom sheet into place to ensure full contact with substrate.

.4 All side and end laps of the base sheet shall be heat welded with hot air gun to the satisfaction of the consultant.

.5 Lap sheets 3” (76mm) for side laps and a minimum 6” (152mm) for end laps. Turn sheet up at perimeters a minimum of 3” (76mm).

6 Application to be free of blisters, wrinkles, and fish-mouths.
Minimum temperature of adhesive at time of application is 70°F (21°C).

.5 Base Sheet Flashing, Self Adhered Installation:

.1 Complete installation of base sheet flashing prior to installing membrane cap sheet and cap sheet flashings.

.2 Prime substrate to receive self-adhering base sheet flashing with specified primer at rate recommended by manufacturer. Avoid pools and heavy areas and allow primer to dry a minimum 30 minutes or until staining does not occur to the touch and surface becomes tacky.

.3 Ensure complete coverage of the primer to both prepared substrates and to the field base sheet membrane prior to placement of the base sheet flashing.

.4 Install base sheet flashing onto substrate in 40" (1m) wide strips extending over perimeters as shown on detail drawings.

.5 Unroll and install base sheet flashing onto substrate by removing the release paper and discarding.

.6 Using weighted roller as recommended by manufacturer, roll all surfaces of roof membrane to ensure continuous adhesion with membrane to substrate. Firmly press the membrane into the substrate to ensure proper bond.

.7 All side and end laps of the base sheet flashing shall be heat welded with hot air gun to the satisfaction of the consultant.

.8 Lap base sheet flashing onto base sheet membrane a minimum 6" (152mm). Side laps between adjacent sheets to be a minimum of 5" (127mm) wide.

.9 Where indicated on details, secure top edge of membrane to substrate with fastening bar and fasteners spaced every 9" (229mm) o/c.

.6 Base Sheet Flashing, Cold Adhesive Installation:

.1 Complete installation of base sheet flashing prior to installing membrane cap sheet and cap sheet flashings.

.2 Apply cold adhesive using notched squeegee at rate recommended by manufacturer. Adhesive to be applied evenly, without skips, voids, or excessive amounts at any location.

.3 Ensure complete coverage of adhesive to both prepared substrates and to the field base sheet membrane prior to placement of the base sheet flashing.

.4 Install base sheet flashing onto substrate in 40" (1m) wide strips extending over perimeters as shown on detail drawings.

.5 Unroll and install base sheet into the prepared substrate and broom sheet into place to ensure full contact with substrate.

.6 All side and end laps of the base sheet flashing shall be heat welded with hot air gun to the satisfaction of the consultant.
between adjacent sheets to be a minimum of 6’ (1219mm) wide.

.8 Where indicated on details, secure top edge of membrane to substrate with fastening bar and fasteners spaced every 9” (229mm) o/c.

.9 Application to be free of blisters, wrinkles, and fish-mouts.

.10 Minimum temperature of adhesive at time of application is 70°F (21°C).

.7 Cap Sheet, Cold Adhesive Installation:

.1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, align and re-roll from both ends.

.2 Apply cold adhesive using notched squeegee at rate recommended by manufacturer. Adhesive to be applied evenly, without skips, voids, or excessive amounts at any location.

.3 Unroll cap sheet into fresh adhesive and broom into place ensuring continuous contact between base and cap sheet membranes.

.4 Withhold adhesive application 2” (51mm) from side and end laps. Hot air weld all side and end laps and ensure continuous bitumen bleed out.

.5 Lap sheets 3” (76mm) for side laps and a minimum 6” (152mm) for end laps. Offset joints in cap sheet 12” (305mm) minimum from those in base sheet.

.6 Application to be free of blisters, wrinkles and fish-mouts.

.7 Ensure membrane application is done in accordance with manufacturer’s recommendations.

.8 Cap Sheet Flashing, Cold Adhesive Installation

.1 Cap sheet flashing to be installed using adhesive at the rate recommended by the roofing manufacturer.

.2 Install adhesive to roof and wall surface using notched trowel. Cover backside of membrane with thin layer of adhesive.

.3 Once adhesive has become tacky, fit membrane into place and use roller to ensure continuous adhesion between base and cap sheet membrane.

.4 Set cap sheet to offset base sheet flashing joints by 50% and extend a minimum of 6” (152mm) onto roof. All end lap joints shall be a minimum 3” (76mm).

.5 All side and end laps of the cap sheet flashing shall be heat welded with hot air gun to the satisfaction of the consultant.

.6 Properly secure flashings to their support without sags, blisters, fish-mouts or wrinkles with termination and fasteners as indicated on detail drawings.

.7 Ensure all work is done in accordance with the manufacturer’s recommendations.

3.14 LIQUID APPLIED RESIN FLASHING MEMBRANE

.1 At all junctions where installation of membrane flashings is not possible, install new liquid applied resin flashing system.

.2 Resin system shall be a layered application consisting of two coats of thixotropic
catalyzed polymethylmethacrylate (PMLMOAW) resin encapsulating a layer of polyester fleece reinforcement.

.3 Installation of liquid applied flashing system to follow in **STRICT ACCORDANCE** with manufacturer's written instructions.

.4 Ensure that substrates are free from gross irregularities, loose, unsound or foreign material such as dirt, ice, snow, water, grease, oil, bituminous products, release agents, laitance, paint, loose particles/friable matter, rust or any other material that would be detrimental to adhesion of the catalyzed primer and/or resin to the substrate.

.5 Some surfaces may require scarification, shot-blasting, or grinding to achieve a suitable substrate. Wipe surfaces with a clean cloth saturated with the specified cleaner/solvent to remove grease, oils or dust that may affect adhesion and to cured PMMA surfaces to receive a subsequent coat of resin.

.6 Concrete substrates to receive an application of the specified PMMA roofing system shall have a maximum moisture content of 6% and a maximum internal relative humidity of 75%.

.7 Preparation of Steel/Aluminum Substrates:

.1 Grind to generate a "white-metal" surface and remove loose particles. Extend preparation area a minimum of ½” (13mm) beyond the termination of the roofing/flashing system. Do not used cleaner/solvent after grinding. Notch steel surfaces to provide a rust-stop where detailed.

.8 Preparation of Wood/Plywood Flashing Substrates to receive Resin:

.1 Tape the joints between plywood or wood panels using the specified tape and prime wood/plywood surfaces to receive the specified flashing system with the specified PMMA-based primer and allow primer to set prior to application of the flashing system.

.9 Preparation of Cover Board Substrates:

.1 Ensure that the insulation panels have been properly secured. Inspect the surface of the panel insulation system to ensure that edges are level and even between adjoining panels. Tape the panel joints and panel terminations at nailers, walls, perimeter and penetrations using the specified tape, centering the tape strips over the joints or panel edges.

.10 Preparation/Mixing/Catalyzing Resin Products:

.1 Pour the desired quantity of resin into a clean container and using a spiral mixer or mixing paddle, stir the liquid for the time period specified by the resin manufacturer.

.2 Calculate the amount of catalyst powder needed using the manufacturer's guidelines and add the pre-measured catalyst to the resin component.

.3 Mix again for the time period specified by the resin manufacturer, ensuring that the product is free from swirls and bubbles.

.4 Ensure that air is not entrained into the product during the mixing process. To avoid aeration, do not use a spiral mixer unless the spiral section of the mixer
can be fully contained in the liquid during the mixing process.

.5 Mix only enough product to ensure that it can be applied before expiration of resin pot life.

.11 Primer Application:

.1 Apply primer resin using a roller or brush at the minimum rate specified by the primer manufacturer over poured reinforced concrete substrates.

.2 Apply primer resin using a roller or brush at the increased rate specified by the primer manufacturer over cover boards and granule surfaced membrane substrates.

.3 Increase application rates over other absorbent substrates. Do not let resin pool or pond. Do not under-apply or over-apply primers as this may interfere with proper primer catalyzation.

.4 Make allowances for saturation of roller covers and application equipment.

.12 Base Flashing Application:

.1 Using masking tape, mask the perimeter of the area to receive the flashing system.

.2 Apply resin primer to substrates requiring additional preparation and allow primer to set.

.3 Pre-cut fleece to ensure a proper fit at transitions and corners prior to membrane application.

.4 Apply an even, generous base coat of flashing resin using a roller at the minimum rate specified by the resin manufacturer to prepared surfaces requiring flashing coverage.

.5 Work the fleece into the wet, catalyzed resin using a brush or roller to fully embed the fleece in the resin and remove trapped air.

.6 Lap fleece layers a minimum of 2" (51mm) and apply an additional coat of catalyzed resin between layers of overlapping fleece.

.7 Using a roller, apply an even top coat of catalyzed resin at the minimum rate specified by the resin manufacturer immediately following embedment of the fleece, ensuring full saturation of the fleece.

.8 Ensure that the flashing resin is applied to extend a 0.25" (6mm) beyond the fleece. Remove the tape before the catalyzed resin sets. Make allowances for saturation of roller covers and application equipment.

.9 Should work be interrupted for more than 12 hours or the surface of the catalyzed resin becomes dirty or contaminated by the elements, wipe the surface to be lapped with new flashing resin using the specified cleaner/solvent.

.10 Allow the surface to dry for a minimum 20 minutes and a maximum 60 minutes before continuing work.

3.15 ROOF PENETRATIONS

.1 Install roof penetration flashings and seal with membrane in accordance with the manufacturer's recommendations and as indicated on detail drawings.
.2 Prime all metal flanges and allow to solvents to flash off prior to installation.

.3 Set metal flange in full layer of rubberized sealing compound ensuring a positive bond.

.4 Install an additional ply of base sheet membrane over the flange as per the manufacturer’s written instruction prior to installing the field cap sheet membrane. The additional ply of membrane to extend a minimum of 6” (152mm) past the edge of the flange.

.5 Install cap ply to the base ply flashing ensuring a full bond to the base ply and apply bead of sealing compound at the termination point.

3.16 CONCRETE PAVERS

.1 Install a minimum of two concrete pavers at both the top and bottom of each roof access ladder, stairways, in front of all entrances, in front of all equipment service panels and as indicated on the drawings.

.2 Pavers are to be set on a layer of 1” Type 4 extruded polystyrene insulation 2” less than dimension of paver (i.e. – 22” x 22” insulation under 24” x 24” paver)

3.17 METAL FLASHINGS

.1 After the installation of the roof membrane and membrane flashings, new perimeter metal and metal flashings shall be installed as detailed in Sheet Metal Flashings Section and as indicated on detail drawings.

3.18 SEALANTS

.1 As per Section 07900 – Sealants.

3.19 DRAINS

.1 General:

.1 Make all joints watertight and gastight.

.2 Install new drains as per the manufacturer’s specifications and detail drawings.

.3 Ensure that the drains are clear of debris and free flowing prior to the installation of the insulation and the membrane.

.4 Any blockages are to be reported prior to the start of work. Once work has begun, the Contractor assumes responsibility for free flowing drains and the cost associated with clearing.

.5 Prior to the installation of new insulation and membrane, ensure that all new and retro drains are located at a height where the roof is able to clear the majority of roof top water caused by rainfall within a 72 hour period.

.6 No roof area shall be left overnight without adequate provision for drainage at the existing roof drain locations.

.7 All plumbing to be executed in accordance with relevant Provincial Building Codes and Local Building Codes.

.2 Drain Installation:

.1 (On Roof Replacement or Alterations) Remove any other components of the existing roof drain which may prevent the retrofit drain flange from sitting flush
.2 Install new base membrane over the drain location prior to installing the drain as per
drawing detail and membrane installation methods.

.3 Primed drain body to be set into a bed of mastic.

.4 (On Roof Replacement or Alterations) Insert the retrofit drain body down into the
existing drain pipe until the retrofit drain flange is embedded into the surface of the
target membrane. If the drain body is too long, it may be shortened by cutting the
copper drain stem prior to installing the U-Flow Seal connection.

.5 The drain body is to be secured to the substrate with a minimum of 4 fasteners per drain
or additional as required to secure the drain body.

.6 Install the reinforcement ply of base sheet membrane and cap ply membrane as per
roofing membrane manufacturer's flashing requirements. Use the U-Flow hole puncher
tool to make neat membrane penetrations for the drain studs.

.7 Place the Clamping Ring over the raised studs. Install stainless steel self locking nuts to
tighten the Clamping Ring against the membrane flashing until secure.

.8 Install ballast guard strainer dome and secure in place with the cotterless pin or wing nut
screw. At paver ballasted areas, drain cover to be flush with the surrounding pavers and
secured with a flush mounted screw.

.3 Scupper Drain Installation:

.1 Install new metal open-top scupper drain at existing scupper location as indicated on roof
plan.

.2 The new scupper is to be fabricated from 24 gauge galvanized metal to suit and complete
with gravel stop edge on three sides. Solder all joints to make continuous water tight
seal. Face of scupper to be encapsulated with prefinished metal cover.

.3 Affix a pre-finished metal open-top collector head at each scupper drain and install new
4" x 4" (102 x 102mm) pre-finished metal rain water leaders.

.4 The rain water leaders shall be open-faced, except for the first 4' (1.2m). Colour shall
match with existing.

.5 At the base of the rain water leaders, install concrete paver on rigid insulation as splash
pad.

.4 Overflow Scupper Drain Installation:

.1 Install new overflow scupper drains at perimeters where indicated on the roof plan
drawing.

.2 Solder all joints to make continuous water tight seal.

.3 Face of scupper to be encapsulated with prefinished metal cover.

.4 Locate mouth opening of new overflow scupper 1" (25mm) above the finished roof
membrane on tapered/sloped roof sections and 3" (76mm) above flat roof sections.

3.20 TEMPORARY WATER CUT-OFFS

.1 Temporary waterproof seals will be placed on daily work. Only areas which can be made
watertight in the same day will be removed to ensure protection of the interior. Temporary seals
.2 All flashings shall be installed concurrently with the roof membrane in order to maintain a watertight condition as the work progresses.

.3 All temporary water-stops shall be constructed to provide a 100% watertight seal. The stagger of the insulation joints shall be made even by installing partial panels of insulation.

.4 The new membrane shall be carried into the water-stop. The water-stop shall be sealed to the deck and/or substrate so that water will not be allowed to travel under the new or existing roofing.

.5 The edge of the membrane shall be sealed in a continuous heavy application of sealant.

.6 When work resumes, the contaminated membrane shall be cut out. All sealant, contaminated membrane, insulation fillers, etc. shall be removed from the work area and properly disposed of offsite. None of these materials shall be used in the new work.

.7 If inclement weather occurs while a temporary water-stop is in place, the Contractor shall provide the labour necessary to monitor the situation to maintain a watertight condition.

.8 If any water is allowed to enter under the newly-completed roofing, the affected area shall be removed and replaced at the Contractor's expense.

3.21 CLEAN-UP

.1 Clean up and remove from job site on a daily basis, all rubbish and surplus materials resulting from this work.

END OF SECTION – 07550
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PART 1 - GENERAL

1.2 SECTION INCLUDES

1.3 RELATED SECTIONS

.1 Section 01110 – Summary of Work
.2 Section 07620 – Sheet Metal Flashing and Trim
.3 Section 07900 – Sealants

1.4 REFERENCES

The latest edition of all listed references shall apply:

.1 ASTM D41 – Asphalt Primer Used in Roofing, Damp-proofing, and Waterproofing.
.2 ASTM D2822 – Asphalt Roof Cement.
.4 ASTM D6162 – Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fibre Reinforcements
.5 ASTM D6163 – Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fibre Reinforcements
.6 ASTM D6164 – Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
.7 CGSB 37-GP-9Ma – Primer, Asphalt, Unfilled, for Asphalt Roofing, Damp-proofing and Waterproofing.
.8 FM (Factory Mutual) – Roof Assembly Classifications.
.12 Conform to National Plumbing Codes and requirements of Provincial and Municipal Authorities. Most stringent requirements shall govern where in conflict.
1.5 **SUBMITTALS**

.1 Provide initial schedule within five (5) working days after Contract award, showing anticipated progress stages and final completion of work. Work shall not commence before work schedule is provided.

.2 Sample copy of Contractor's warranty.

.3 Certifications by manufacturers of roofing and insulating materials that all materials supplied comply with all requirements of the identified ASTM and other industry standards or practices.

.4 Certification from the Contractor that the system specified meets all identified code and insurance requirements as required by the Specification.

1.6 **CONTRACTOR QUALIFICATION**

.1 Contractor and his staff must be certified by the membrane manufacturer and pre-approved by the Owner and Consultant prior to tender,

.2 Contractor must be a member in good standing with the Ontario Roofing Contractors Association (OIRCA) and have a minimum ten (10) years relevant experience with similar roof materials.

.3 Pre-approved Roofing Contractors with University of Toronto are:

- Atlas-Apex Roofing – 416.421.6244
- Bothwell-Accurate Roofing – 416.762.8243
- Dean-Chandler Roofing – 416.751.7840
- Semple Gooder Roofing – 416.743.5370
- Schreiber Brothers Roofing – 905.561.7780
- York Roofing – 416.661.1883

1.7 **QUALITY ASSURANCE**

.1 Perform Work in accordance with manufacturer’s written instructions.

.2 There shall be no deviation made from the Project Specification or the approved shop drawings without prior written approval by the Owner, the Owner's Representative, and the manufacturer.

1.8 **REGULATORY REQUIREMENTS**

.1 Conform to applicable local code for roof assembly fire hazard requirements.

.2 UL: Class B Fire Hazard Classification.

.3 FM: Roof Assembly Classification, of Class 1 Construction, wind uplift requirement of I-90, in accordance with FM Construction Bulletin 128.

1.9 **SPECIAL SITE INSTRUCTIONS**

.1 Interior Protection for work to be provided by Contractor.

.2 Minimize disruptions to regular building activities. Noisy Work to be performed outside of regular office/operating hours. Arrange special access and times to project site with Designee.

.3 Staging area to be determined on site with Consultant and Building Owner.
.4 All salvaged copper flashings, cleats, and hook strips from the designated roof replacement areas to be recycled and subsequent value credited to the Building Owner.

.5 No asphalt kettles on site. Project to be free of mopping and torching applications. All roof elements to be mechanically fastened, adhered in bonding agent, or cold applied. All membranes to be self adhering or cold applied.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 All work to be conducted from the exterior using swing-stage, hoist, etc.

.2 Site storage is limited. Location of storage to be coordinated with Owner.

.3 All materials shall be delivered and stored in their original packaging bearing the manufacturers label, grade and product weight, including all other related standards, specifications, and the like.

.4 All materials shall be adequately protected from inclement weather conditions and stored in a dry, well ventilated and weather protected location.

.5 Only materials to be installed on the same day shall be removed from the protected location to the work site.

.6 During extreme temperature, materials shall be stored in a heated location with a 40°F (4.4°C) minimum temperature and removed only as needed.

.7 All materials in a rolled configuration shall be stored on end, elevated off the ground on a pallet or skid, to protect the bottom surface from foreign debris and moisture.

.8 When possible, the Contractor should restrict stock piling of material in one location on the roof surface to prevent exceeding the specified deck live load capacity.

.9 Handle and store products in a manner to prevent damage and deterioration.

.10 Remove and replace damaged products at own expense and to the satisfaction of the Consultant.

1.11 ENVIRONMENTAL REQUIREMENTS

.1 Do not apply roofing membrane to damp or frozen deck surface.

.2 Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

.3 Only as much of the new roofing as can be made weather-tight each day, including all flashing and detail work, shall be installed. All seams shall be heat welded with hot air gun before leaving the job site that day.

.4 All work shall be scheduled and executed without exposing the interior building areas to the effects of inclement weather. The existing building and its contents shall be protected against all risks.

.5 All new and temporary construction, including equipment and accessories, shall be secured in such a manner as to preclude wind blow-off and subsequent roof or equipment damage.

.6 Uninterrupted water-stops shall be installed at the end of each day's work and shall be completely removed before proceeding with the next day's work. Water-stops shall not emit dangerous or unsafe fumes and shall not remain in contact with the finished roof as the installation progresses. Contaminated membrane shall be replaced at no cost to the Owner.
Prior to and during application, all dirt, debris and dust shall be removed from surfaces by vacuuming, sweeping, blowing with compressed air, and/or similar methods.

The Contractor shall follow all safety regulations as required by OHSA (Occupational Health and Safety Act) and any other applicable authority having jurisdiction.

All roofing, insulation, flashings and metal work removed during construction shall be immediately taken off site to a legal dumping area authorized to receive such materials. Hazardous materials, such as materials containing asbestos, are to be removed and disposed of in strict accordance with applicable Municipal, Provincial, Federal, and University of Toronto requirements.

All new roofing waste material (i.e., scrap roof membrane, empty cans of adhesive) shall be immediately removed from the site by the Contractor and properly transported to a legal dumping area authorized to receive such material.

The Contractor shall take precautions that storage and/or application of materials and/or equipment does not overload the roof deck or building structure.

Flammable adhesives and deck primers shall not be stored and not be used in the vicinity of open flames, sparks and excessive heat.

All rooftop contamination that is anticipated or that is occurring shall be reported to the manufacturer to determine the corrective steps to be taken.

The Contractor shall verify that all roof drain lines are functioning correctly (not clogged or blocked) before starting work. Contractor shall report any such blockages in writing to the Owner's Representative for corrective action prior to the installation of the roof system.

The Contractor shall immediately stop work if any unusual or concealed condition is discovered and shall immediately notify Owner of such condition in writing for correction at the Owner's expense.

Site cleanup, including both interior and exterior building areas that have been affected by construction, shall be completed to the Owner's satisfaction.

All landscaped areas damaged by construction activities shall be repaired at no cost to the Owner.

Precautions shall be taken when using adhesives at or near rooftop vents or air intakes. Adhesive odours could enter the building. Coordinate the operation of vents and air intakes in such a manner as to avoid the intake of adhesive odour while ventilating the building. Keep lids on unused cans at all times.

Protective wear shall be worn when using solvents or adhesives or as required by job conditions.

EXAMINATION

Examine the Drawings and Specifications to determine the extent of the work involved, together with other necessary data affecting the work, as in no circumstances will any claims against the Owner be allowed resulting from failure to ascertain the extent of such work herein described or implied.

QUALITY OBSERVATION ASSURANCE

An Independent Quality Assurance Observation Consultant retained by the University's Project Manager will be appointed to observe the installation.
.2 Arrange site meeting with the Observer no more than three weeks prior to commencement of work on site. Obtain the Observer’s instructions with reference to procedures to be followed. Contractor to provide Observer with the following at this meeting:

.1 Notice of Project
.2 A sample copy of the Warranty
.3 A copy of the letter and completed project warranty form sent to the “Warranty Holder” advising them of the project starting
.4 Bonds and Insurance in the Owner’s Name
.5 WSIB Clearance Certificate
.6 A Contact List complete with 24-hour emergency phone numbers
.7 A Work Schedule listing start date, number of working days and manpower for the project shop drawings for tapered insulation, if applicable
.8 A complete Material List
.9 MSDS information pertaining to ALL materials being used on site
.10 The appropriate securement patterns for mechanically fastening of the insulation, if applicable
.11 A list of the “Trained and Carded Membrane Approved Applicators” who will be working on site

.3 Cooperate with the Observer and afford all facilities necessary to permit full QA observation of the work. Act immediately on instructions given by the Observer.

.4 Make cut-outs when required and make good roofing without additional costs to the Owner.

1.14 SAFETY AND PROTECTION

.1 The latest edition of all listed references shall apply:

.1 CAN/CSA S269.2M – Access Scaffolding for Construction Purposes.

.2 Solvents, adhesives and membranes

.1 Store only enough solvents and adhesives on the roof for the same day’s use, do not leave adhesives on roof overnight. Manufacturer supplied adhesives should be stored in their overnight containers. Minimum temperature for solvent based adhesive and primers is -5°C.

1.15 WARRANTY

.1 Contractor shall supply the Owner with a one (1) year Contractor OIRCA Warranty for workmanship. In the event any work related to roofing, flashing, or metal is found to be within the Contractor warranty term, defective or otherwise not in accordance with the Contract Documents, the Contractor shall repair that defect at no cost to the Owner. The Applicator’s warranty obligation shall run directly to the Owner.
.2 Owner shall notify both the membrane manufacturer and the Contractor of any leak that occurs during the time period when both warranties are in effect.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Note all membrane materials are to be supplied by one manufacturer: Siplast or Soprema, meeting manufacturer’s respective material compatibility requirements to achieve the required System Warranty.

.2 Components to be used that are other than those supplied or manufactured by the membrane manufacturer may be submitted for review and acceptance by the membrane manufacturer.

.3 The membrane manufacturer's acceptance of any other product is only for a determination of compatibility with the products and not for inclusion in the manufacturer's warranty.

.4 The specifications, installation instructions, limitations, and/or restrictions of the respective manufacturers must be reviewed by the Owner's Representative for acceptability for the intended use with the membrane manufacturer's products.

2.2 N.V.S. REPAIR COMPOUND

.1 N.V.S. Repair Compound: NVS Premix by Siplast

2.3 MEMBRANE & MEMBRANE FLASHING

.1 Venting Base Sheet:

.1 Mechanically secured fibreglass, asphalt coated fibreglass base sheet meeting ASTM D4601, Type II; Parabase FS by Siplast or Sopraglass 100 by Soprema.

.2 Base Sheet:

.1 Adhesive grade modified bitumen, minimum thickness 3.0mm, with minimum 180g/m², random fibre glass mat or non-woven polyester, impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M; Paradiene 20 HV by Siplast or Colply Base 410 by Soprema.

.3 Base Sheet Flashing:

.1 Self-adhering grade modified bitumen, minimum 3.0mm thick, with random fibre glass mat impregnated and coated with SBS modified bitumen, and coated with self-adhesive bitumen layer and polyolefin release film on bottom surface, and conforming to CGSB 37-GP-56M; Paradiene 20 EG SA by Siplast or Sopralene Stick Adhesive by Soprema.

OR

.2 Adhesive grade modified bitumen, minimum thickness 3.0mm, with minimum 180g/m², random fibre glass mat or non-woven polyester, impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M; Paradiene 20 HV by Siplast or Sopralene Stick Adhesive by Soprema.

.4 Cap Sheet:

.1 Adhesive grade modified bitumen, minimum thickness 3.6mm, with minimum 250g/m², fibreglass scrim/polyester composite impregnated and coated with SBS modified
bitumen, and conforming to CGSB 37-GP-56M; Paradiene 30 by Siplast or Colply Traffic Cap 460 by Soprema.

.5 Cap Sheet Flashing:

.1 Adhesive grade modified bitumen, minimum thickness 3.6mm, with minimum 250g/m², fibreglass scrim/polyester composite impregnated and coated with SBS modified bitumen, and conforming to CGSB 37-GP-56M; Parafor 30 by Siplast or Colply Traffic Cap 460 by Soprema.

.6 Membrane Primer:

.1 Solvent based primer to prepare surfaces before the installation of membranes, PA-1125 Primer by Siplast or Elastocol Stick by Soprema.

.7 Membrane Adhesive:

.1 Solvent based adhesive; PA-311 adhesive by Siplast or Colply Adhesive Brush for horizontal surfaces and Colply Adhesive Trowel Grade for sloped surfaces by Soprema.

2.4 LIQUID APPLIED RESIN FLASHING MEMBRANE

.1 Polymethylmethacrylate (PMMA) Primers: as recommended by the membrane manufacturer.

.2 PMMA Roofing Flashing (Soprema):

.1 Resin for flashing applications: a one-component polyurethane/bitumen resin for use in combination with fleece fabric to form a monolithic, reinforced flashing membrane; Alsan Flashing from Soprema.

.2 Fleece for flashing reinforcement: A woven, 100 g/m², polyester fabric reinforcement as supplied by the membrane system manufacturer; Flashing Reinforcement by Soprema.

.3 PMMA Roofing Flashing (Siplast):

.1 Catalyst: Pro Catalyst by Siplast.

.2 Resin for flashing applications: A flexible, polymethylmethacrylate (PMMA) based resin combined with a thixotropic agent for use in combination with fleece fabric to form a monolithic, reinforced flashing membrane; Parapro 123 Flashing Resin by Siplast.

.3 Resin for field membrane: A flexible, polymethylmethacrylate (PMMA) based resin for use in combination with fleece fabric to form a monolithic, reinforced roofing membrane; Parapro Roof Resin by Siplast.

.4 Fleece for membrane and flashing reinforcement: A non-woven, 110 g/m², needle-punched polyester fabric reinforcement as supplied by the membrane system manufacturer; Pro Fleece by Siplast.

.5 Clear finish resin: A clear, flexible, polymethylmethacrylate (PMMA) based resin for use as a wearing coat over colored quartz; Pro Clear Finish by Siplast.

.6 Thixotropic agent: A liquid additive used to increase the viscosity of the PMMA-based resin products, allowing the resins to be applied over vertical or sloped substrates; Pro Thixo by Siplast.

.4 Anti-Skid Surfacing:
2.5 ROOF ACCESSORIES

.1 Ceramic granules: No. 11 grade specification ceramic granules suitable for broadcast into the PMMA based wearing layer; No. 11 Granules by Siplast or approved equal from Soprema.

.5 PMMA Accessories:

.1 Cleaning solution/solvent: A clear solvent used to clean and prepare transition areas of in-place catalyzed resin to receive subsequent coats of resin and to clean substrate materials to receive resin; Pro Prep by Siplast or approved equal from Soprema.

.2 Tape: A white, flexible, coated cotton cloth tape designed for treatment of insulation panel joints, deck/wall transitions and joints in flashing substrates; Pro Tape by Siplast or approved equal from Soprema.

2.6 FASTENERS AND PLATES

.1 Insulation to steel and wood deck:

.1 Tru-Fast Ultra Solid Stainless Steel fastener to penetrate substrate by 3/4" (19mm). Plates to be 3" diameter. Tru-Fast Galvalume stress plate.

.2 Wood to steel, wood to wood or steel to steel:

.1 Tru-Fast Ultra Solid Stainless Steel fastener to penetrate substrate by minimum 3/4" (19mm).

.3 Wood/steel to concrete or concrete block:

.1 Perma-Grip Tap Grip H.D. Truss Head fastener with Perma-Coat Z3 corrosion protection to penetrate substrate by 1 1/4" (32mm).

.2 Tru-Fast Tap Grip H.D. Truss Head fastener with Perma-Coat Z3 corrosion protection to penetrate substrate by 1 1/4" (32mm).

.4 Steel/aluminum to aluminum:

.1 Tru-Fast DP with Trucote PC-3 corrosion protection fastener c/w EPDM galvanized steel sealing washers to penetrate substrate by 3/4" (19mm).

.5 Termination bar for membrane:

.1 Extruded aluminum, 0.060" thick x 1" wide x 10' long with 1/4" x 3/8" slotted holes on 8" (203mm) o/c. Acceptable material: TB-120 aluminum termination bar by Tru-Fast.

.6 Termination bar fastener for wood, steel or aluminum:

.1 Tru-Fast Ultra Solid Stainless Steel fastener to penetrate substrate by 3/4" (19mm) c/w EPDM galvanized steel sealing washers or Construction Fasteners Inc. Woodgrip #14
screw complete with Sentri coating on threads, Chromagard colour match head and EPDM washer

.7 Termination bar fastener for concrete or masonry:

.1 Tru-Fast Tap Grip Truss Head fastener with Perma-Coat Z3 corrosion protection to penetrate substrate by 1 1/4" (32mm) c/w EPDM galvanized steel sealing washers.

.8 Pre-painted metal flashing to steel or wood:

.1 Construction Fasteners Inc. Woodgrip #14 screw complete with Sentri coating on threads, Chromagard colour match head and EPDM washer or approved equal. Fastener to penetrate substrate by minimum 3/4".

.9 Membrane to wood:

Galvanized round top nails with minimum 1" diameter heads to penetrate the substrate a minimum 1 1/4" (32mm).

.10 Venting Sheet Membrane to Lightweight Concrete:

.1 NVS fasteners as manufactured by Siplast or Soprema. Specialty fasteners are as specified in the scope of work or as required in drawings.

.11 All fasteners and plates to meet the requirements of Factory Mutual 4470 Standard for wind uplift and corrosion resistance.

PART 3 - EXECUTION

3.1 WORKMANSHIP

.1 Execute roofing work which is not specifically covered by these Specifications in accordance with applicable standards in Canadian Roofing Contractors Association (CRCA) and the National Roofing Contractors Association Roofing Specification Manual, in accordance with the Canadian Modified Bitumen Manufacturer’s Association’s recommendations, in accordance with the manufacturer’s preprinted and published specifications and to ULC Design No. S-107, to FM 1-28 and 1.49 criteria, compliance with local fire insurance requirements and/or local building codes, except where specified otherwise.

.2 Do priming for asphalt roofing in accordance with CAN/CGSB 37-GP-15M and as recommended by membrane manufacturer.

.3 Procedures for application of materials should be in accordance with manufacturer’s recommendations; otherwise the Consultant should be notified if any conflict with this Specification arises.

.4 All work shall be carried out in accordance with drawings, specifications and contract documents.

.5 Adhesives or sealants and liquid primers will not be applied until surfaces are dry.

.6 Inspect the underside of roof deck when installing fasteners, where possible, to avoid accidental damage.

.7 While work is in progress, all steps must be taken to safeguard the building from damage due to the elements.

.8 Consultant must be notified of adjustments to specified roofing procedures recommended by the Manufacturer or due to site conditions. Written approval from the independent Consultant is required to make any adjustments to the specified procedures.
3.2 EXAMINATION OF SITE CONDITIONS

.1 Inspect existing conditions and substrates upon which work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of work implies acceptance of existing conditions and assuming full responsibility for the finished condition of the work.

.2 Defective work resulting from application to unsatisfactory conditions will be considered the responsibility of those performing the work of this section.

3.3 PREPARATION

.1 Examine all site conditions to ensure that they are in satisfactory condition for the commencement of the work of this section.

.2 Examine work of other trades for defects and discrepancies and report them to the owner/consultant in writing. Do not proceed with work until surfaces are satisfactory.

.3 Ensure roof drains have been installed at proper elevations relative to finished roof surface in order to allow for sufficient drainage of the roof surface.

.4 Disconnect Electrical Services as required.

.5 Disconnect Mechanical Equipment as required.

.6 Ensure that projections and any equipment (electrical conduit, gas lines etc.) are correctly secured to the decking where applicable. If any inadequate securement is found, the Consultant is to be informed and work around that area is to be halted until the situation has been rectified.

.7 Any rooftop equipment requiring disconnection shall be the responsibility of the Contractor in consultation with the owner unless otherwise specified in this document.

.8 Inspect wood blocking, cants and the like. Do not install roofing unless such items are adequately installed to withstand stresses imposed by thermal movement of the roof components.

.9 Apply each part of roofing system when surfaces are free of moisture for successful application. Consult with manufacture’s printed instructions for successful application.

.10 All details supplied with this scope of work package are acceptable installations. Any deviance from these details must first approved by the Consultant prior to installation.

3.4 PROTECTION

.1 Cover walls and adjacent work where materials are hoisted and used.

.2 Use warning signs and barriers. Maintain in good order until completion of work.

.3 Protect roof from traffic and damage by placing suitable runways over all new membrane work. Comply with precautions deemed necessary by Consultant.

.4 At end of each day’s work, or when stoppage occurs due to inclement weather, provide protection for completed work and materials out of storage.

.5 Contractor is to take care as not to damage any previously performed work, any closely located buildings and all grounds in the vicinity during roofing operations. Contractor shall protect against dust infiltration and other such occurrences. Garbage chutes are to be located as to minimize their exposure to the building and its occupants. Protect walls by means of tarpaulins where garbage chutes and hoisting equipment is located. Cover dumpsters and bins so that debris does not blow away.
.6 Only equipment that will not adversely affect the deck (damage or alter) is to be used.

.7 Roof access is to be unobstructed. Doorways and fire routes are to be kept clear of any obstacles.

.8 Examine and repair or replace damage caused by work of this contract with materials and finish to match original to Consultant’s approval.

.9 All non-used materials are to be removed and stored at a location that will prevent any damage (moisture, ultraviolet breakdown, etc.).

.10 All materials for the project are to be delivered to the site. Materials are to arrive in undamaged condition with the original manufacturer’s label intact and clearly visible for easy verification of materials to specified materials.

.11 When temperatures fall below 40°F, any materials such as membrane, adhesives and sealants that are affected by cool temperatures are to be stored in heated storage areas.

.12 Protect rolls from flattening by storing on ends on skids.

.13 Moisture sensitive products and exposed building substrates are to be protected with all work being halted during inclement weather including but not limited to rain fall, snow, drizzle, fog and hail.

.14 Protect all openings and safeguard all vents, stacks, and drains from weather and contamination from debris.

.15 Defective work resulting from application of material on unsatisfactory surface will be considered the responsibility of the Contractor.

3.5 N.V.S. INSULATION SYSTEM REPAIRS

.1 Areas with damaged concrete substrate must be repaired before any further work can take place on that particular roof section.

.2 Dry out any areas of the existing lightweight concrete surfaces that are damp or wet. Repair any sections of the concrete substrates that are spalled or flaking with specified compound.

.3 At the repair section, remove the existing lightweight concrete to a minimum depth of 1” (25mm) or to sound concrete, whichever is greater.

.4 Prior to application of patching compound, remove debris from the repair area and remove deteriorated concrete material down to a sound substrate.

.5 Moisten the surface of the repair area with water.

.6 Following the manufacturer’s instructions for mixing product preparation and application.

.7 Finish the surface of the patch area to a smooth surface.

.8 Trowel finish any edges to provide a smooth transition to the surface of the existing substrate.

3.6 MODIFIED BITUMEN MEMBRANE REPAIRS

.1 Modified bitumen membrane repairs to be carried out with new materials using the same type of membrane and bitumen already installed in the existing membrane system. All supplied roof materials to be compatible with the existing roof system components.
.2 Cut out damaged and deteriorated existing membrane sections in logical rectangular segments as required. Dispose of all debris and dirt to an appropriate site.

.3 Use two (2) plies of new specified modified bitumen base sheet and cap sheet membrane with an attachment method appropriate for existing building and installation.

.4 Cap sheet membrane to have granulated surface where left exposed. Colour to match existing as close as possible.

.5 Install new modified bitumen base sheet across repair area and extend minimum 4” (102mm) past edge, on to existing modified bitumen membrane. Ensure a good bond to existing membrane. Self-adhering base sheet flashings to be installed with membrane primer as specified.

.6 Carry new modified bitumen cap sheet over new base sheet and extend a minimum of 4” (102mm) past edge, on to existing modified bitumen membrane. Ensure a good bond to existing membrane.

.7 ALL SIDE AND END LAPS OF THE BASE SHEET AND CAP SHEET SHALL BE HEAT WELDED WITH HOT AIR GUN TO THE SATISFACTION OF THE CONSULTANT.

### MODIFIED BITUMEN FLASHING MEMBRANE REPAIRS

.1 All modified bitumen membrane flashing repairs to be carried out with new modified bitumen flashings. All new roof materials to be compatible with the existing roof system components.

.2 Modified bitumen membrane flashing repairs are to consist of two (2) plies of new specified modified bitumen membrane using attachment method appropriate for existing building and installation.

.3 Extend new base sheet flashings a minimum 4” (102mm) past the existing repair area. Self-adhering base sheet flashings to be installed with membrane primer as specified.

.4 Carry new cap sheet flashing a minimum of 4” (102mm) past the base sheet flashing. Ensure a good bond between the modified bitumen flashings.

.5 ALL SIDE AND END LAPS OF THE BASE SHEET FLASHING AND CAP SHEET FLASHING SHALL BE HEAT WELDED WITH HOT AIR GUN TO THE SATISFACTION OF THE CONSULTANT.

### ROOF PENETRATION REPAIRS

.1 Install roof penetration flashings and seal with membrane in accordance with the manufacturer's recommendations and as indicated on detail drawings.

.2 Prime all metal flanges and allow to solvents to flash off prior to installation.

.3 Set metal flange in full layer of rubberized sealing compound ensuring a positive bond.

.4 Install an additional ply of base sheet membrane over the flange as per the manufacturer’s written instruction prior to installing the field cap sheet membrane. The additional ply of membrane to extend a minimum of 6” (152mm) past the edge of the flange.

.5 Install cap ply to the base ply flashing ensuring a full bond to the base ply and apply bead of sealing compound at the termination point.
3.9 METAL FLASHINGS

.1 After the installation of the roof membrane and membrane flashings, new perimeter metal and metal flashings shall be installed as detailed in Section 07620 and as indicated on detail drawings.

3.10 SEALANTS

.1 As per Section 07900 – Sealants.

3.11 TEMPORARY WATER CUT-OFFS

.1 Temporary waterproof seals will be placed on daily work. Only areas which can be made watertight in the same day will be removed to ensure protection of the interior. Temporary seals will be removed before proceeding with the remaining work.

.2 All flashings shall be installed concurrently with the roof membrane in order to maintain a watertight condition as the work progresses.

.3 All temporary water-stops shall be constructed to provide a 100% watertight seal. The stagger of the insulation joints shall be made even by installing partial panels of insulation.

.4 The new membrane shall be carried into the water-stop. The water-stop shall be sealed to the deck and/or substrate so that water will not be allowed to travel under the new or existing roofing.

.5 The edge of the membrane shall be sealed in a continuous heavy application of sealant.

.6 When work resumes, the contaminated membrane shall be cut out. All sealant, contaminated membrane, insulation fillers, etc. shall be removed from the work area and properly disposed of offsite. None of these materials shall be used in the new work.

.7 If inclement weather occurs while a temporary water-stop is in place, the Contractor shall provide the labour necessary to monitor the situation to maintain a watertight condition.

.8 If any water is allowed to enter under the newly-completed roofing, the affected area shall be removed and replaced at the Contractor's expense.

3.12 CLEAN-UP

.1 Clean up and remove from job site on a daily basis, all rubbish and surplus materials resulting from this work.

END OF SECTION – 07550
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Door Hardware Standards

1. General

Early in the planning stages of a project, the Designer must meet with the University of Toronto Project Manager and a representative from the Lock Shop to review the needs for locks and hardware.

Also early in the project, a determination must be made regarding the need for or desirability of including a security access system in the building. If security access is to be integrated into the building, the system must be designed in consultation with the University of Toronto Police.

In an effort to move toward barrier free access across campus, any renovation work will incorporate the use of lever handles that turn in towards the door on all doors except in the case of:

- Historical or Heritage buildings.
- All utility rooms.
- All stairwell exits.

All barrier free access doors incorporating the use of a door operator will follow the design standards set by the University of Toronto on the attached drawings.

Any new products introduced to the University of Toronto must be beta tested on the Campus for a minimum period of 6 months before being listed as an approved alternate.

All Hardware must come with written warranties as listed:
- Locksets 2 years
- Exit devices 2 years
- Door closers 10 years
- Door operators 5 years
- Door pulls 5 years
- Electric Strikes 5 years
- Electric locksets 5 years
- Electric panic devices 5 years
- Hinges full mortise 10 years
- Hinges, continuous 10 years
- Door seals 5 years
2. **Keying**

The requirements for all keying systems are to be carried out by the University of Toronto Lock shop. All Cylinders for locksets to be supplied and installed by the University of Toronto Lock Shop.

3. **Hardware Specifications**

**Closers**

Floor mounted door closers are unacceptable. Surface mounted overhead type is preferred. All closers should be field serviceable.

Closers at exterior doors and all stairwell doors shall be equivalent to an L.C.N 4040 or better.

Closers at all other doors shall be equivalent to an L.C.N 1460 or better.

**Door operators**

Operators shall be Horton 4000 series for all doors with the exception of a single stall barrier free washroom which shall be a Horton 7000 series or better shall be used.

**Locksets**

All locksets to be American Standard Mortise lockset. The function will be determined by Facilities & Services depending on location.

**Exit devices**

All exit devices shall be a flat bar regular stile device.

If required all exterior doors shall use cylinder dogging on the exit device.

**Hinges**

All hinges on oversized doors shall be a continuous hinge.

All hinges for interior doors shall be a full mortise hinge.

All electric transfers through any door shall be concealed wire contact transfer hinge.

**Note:** Pivot hinges are not acceptable.
**Electric Locking Devices**

All doors using a card access system and/or barrier free access, shall use electric latch retraction panic device or an electric mortise lockset with request to exit feature.

No electric strikes shall be used with the exception of:
- Barrier free washrooms.
- Where there is no other possible way of using electric locks.

All electric locking device shall be 24 volts dc with the exception of standalone battery operated locksets.

**Door Pulls and Kick Plates**

Door pulls with through bolt fixing should be at or near the same height as push plates so that the pull bolts will be hidden. Hardware which will require regular polishing or maintenance should be avoided. All edges should be rounded. Kick plates on doors should be stainless steel for full width of actual door.

**Standard measurements**

The following standard hardware heights shall be observed:

- Door Pulls 700mm to 1200mm
- Push Plate 1150mm to centre line
- Door Bar 1000mm to centre line
- Door Lever 1000mm to centre line
- Dead lock (bolt) 1300mm to centre line
- Exit Device Bolt 950mm to centre line
# List of Approved Manufacturers

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<thead>
<tr>
<th>Mortise Locksets</th>
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<tr>
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<td>Von Duprin</td>
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<td>McKinney</td>
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<td>National Guard Products</td>
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</table>
1. TOUCH PADS SHALL BE SUPPLIED BY GENERAL TRADE, & INSTALLED & WIRED BY ELECTRICAL CONTRACTOR.

2. DOOR OPERATOR SHALL BE SUPPLIED & INSTALLED BY GENERAL TRADE, & WIRED BY ELECTRICAL CONTRACTOR.

3. THIS WIRING SCHEMATIC IS APPLICABLE TO HORTON DOOR OPERATORS ONLY. COORDINATE WITH HORTON AUTOMATICS FOR WIRING DETAILS.

4. ALL LOW VOLTAGE WIRING SHALL BE STRANDED & SHIELDED COPPER CONDUCTORS INSTALLED IN CONDUIT OR PLENUM RATED IN HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.

5. LOW VOLTAGE WIRING FINAL CONNECTIONS & COMMISSIONING OF THE DOOR OPERATOR SYSTEM BY HORTON AUTOMATICS, TEL. 905-331-7491, 1-800-866-9523

6. USE BX (AC90) FOR POWER WIRING TO THE DOOR OPERATOR ONLY THROUGH HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.
1. TOUCH PADS SHALL BE SUPPLIED BY GENERAL TRADE & INSTALLED & WIRED BY ELECTRICAL CONTRACTOR.

2. DOOR OPERATOR SHALL BE SUPPLIED & INSTALLED BY GENERAL TRADE & WIRED BY ELECTRICAL CONTRACTOR. ELECTRIC STRIKE SHALL BE SUPPLIED BY GENERAL TRADE & INSTALLED & WIRED BY ELECTRICAL CONTRACTOR.

3. THIS WIRING SCHEMATIC IS APPLICABLE TO HORTON DOOR OPERATORS ONLY. COORDINATE WITH HORTON AUTOMATICS FOR WIRING DETAILS.

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6. USE BX (AC90) FOR POWER WIRING TO THE DOOR OPERATOR ONLY THROUGH HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.
OPERATION

K1 INSIDE KEY SWITCH RESTRICTS DOOR OPERATOR FROM EXTERIOR AFTER HOURS. INTERIOR TOUCH PAD OPENS DOOR IN DAY OR NIGHT MODE. KEY SWITCH SHALL BE COMPLETE WITH MAINTAINED CONTACTS LED. OUTLET BOX TO ALLOW THE KEY FACE PLATE TO BE MATCHED TO THE BOX MOUNTING HOLES AND TAMPER PROOF SCREWS FOR MOUNTING THE KEY FACE PLATE. KEY SWITCH TO MATCH MASTER BUILDING KEY.

K2 EXTERIOR KEY SWITCH OPENS THE DOOR AFTER HOURS. EXTERIOR TOUCH PAD OPENS DOOR IN DAY MODE ONLY. KEY SWITCH SHALL BE COMPLETE WITH MOMENTARY CONTACT. OUTLET BOX TO ALLOW THE KEY FACE PLATE TO BE MATCHED TO THE BOX MOUNTING HOLES AND TAMPER PROOF SCREWS FOR MOUNTING THE KEY FACE PLATE. KEY SWITCH TO MATCH BUILDING MASTER KEY.

1. TOUCH PADS AND KEY SWITCHES SHALL BE SUPPLIED BY GENERAL TRADE & INSTALLED & WIRED BY ELECTRICAL CONTRACTOR.

2. DOOR OPERATOR SHALL BE SUPPLIED & INSTALLED BY GENERAL TRADE & WIRED BY ELECTRICAL CONTRACTOR. KEY CYLINDERS BY U. of T. LOCKSHOP & ELECTRIC STRIKE BY GENERAL TRADE. ELECTRIC STRIKE INSTALLED & WIRED BY ELECTRICAL CONTRACTOR.

3. THIS WIRING SCHEMATIC IS APPLICABLE TO HORTON DOOR OPERATORS ONLY. COORDINATE WITH HORTON AUTOMATICS FOR WIRING DETAILS.

4. ALL LOW VOLTAGE WIRING SHALL BE STRANDED & SHIELDED CONDUCTORS INSTALLED IN CONDUIT OR PLENUM RATED IN HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.


6. USE BX (AC90) FOR POWER WIRING TO THE DOOR OPERATOR ONLY THROUGH HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.
PLAN VIEW

TO F&S SWITCH

1B, 1D

1A, 1B

DIM

1C

INTERIOR

TO F&S SWITCH

CEILING LINE

3/4” C

DOOR CONTACT

MOUNT ON EXTERIOR SIDE

ELEVATION

(INTERIOR)

ELECTRIC DEVICE

HONEYWELL DOOR DETAILS

HONEYWELL FAULT TOLERANT SERIES
INTERIOR DOOR WIRING SCHEMATIC
DOUBLE DOOR WITH CARD READER & SINGLE ACTIVE LEAF

University of Toronto
UPDC
DESIGN & ENGINEERING

Title:

HONEYWELL FAULT TOLERANT SERIES
INTERIOR DOOR WIRING SCHEMATIC
DOUBLE DOOR WITH CARD READER & SINGLE ACTIVE LEAF

Drawn by: GDP

Scale: N.T.S.

Date: 06 DEC 2019

Project No.

Drawing No.

HFT-INT-03
## WIRE & CABLE LEGEND

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## FIELD DEVICE LEGEND

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<tr>
<td>DIM</td>
<td>DOOR INTERFACE MODULE</td>
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![Wire Tagging Diagram]

**Cable Type**

**Quantity of Indicated Cable Type**

---

**Honeywell Door Details**

**Title:** HONEYWELL FAULT TOLERANT SERIES WIRE & CABLE LEGENDS & WIRE TAGGING DIAGRAM

**Drawn by:** GDP

**Scale:** N.T.S.

**Date:** 06 DEC 2019

**Project No.:** HFT-INT-06
NOTES: (INTERIOR DOOR)

1. FOR EXACT HEIGHTS, REFER TO ARCHITECTURAL DRAWINGS.

2. LOW VOLTAGE WIRING SHALL BE COPPER CONDUCTORS.

3. ALL LOW VOLTAGE WIRING SHALL BE STRANDED & SHIELDED INSTALLED IN CONDUIT OR PLENUM RATED IN HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.

4. MINIMUM CONDUIT SIZE TO BE 3/4”.

SEQUENCE OF OPERATION
(INTERIOR DOOR WITH CARD READER):

FOR LOCKED DOORS:

- CARD READER UNLOCKS DOOR.
- ONCE CLOSED, DOOR LOCKS.
- IF DOOR IS LEFT AJAR, BUZZER WILL SOUND.
WIRE & CABLE LEGEND

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<td>9740</td>
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<td>JUNCTION BOX (ACCESSIBLE FOR MAINTENANCE)</td>
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NOTES: (INTERIOR DOOR)

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2. LOW VOLTAGE WIRING SHALL BE COPPER CONDUCTORS.

3. ALL LOW VOLTAGE WIRING SHALL BE STRANDED & SHIELDED INSTALLED IN CONDUIT OR PLENUM RATED IN HOLLOW METAL DOOR FRAME WHERE ACCESSIBLE.

4. MINIMUM CONDUIT SIZE TO BE 3/4”.

SEQUENCE OF OPERATION
(INTERIOR DOOR WITH CARD READER):

FOR LOCKED DOORS:

- CARD READER UNLOCKS DOOR.
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- IF DOOR IS LEFT AJAR, BUZZER WILL SOUND.
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<td>DOOR ACTIVATION DEVICE</td>
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<tr>
<td>DO</td>
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SEQUENCE OF OPERATION
(INTERIOR DOOR WITH CARD READER):

FOR LOCKED DOORS:
- CARD READER UNLOCKS DOOR.
- ONCE CLOSED, DOOR LOCKS.
- IF DOOR IS LEFT AJAR, BUZZER WILL SOUND.

WIRE TAGGING

CABLE TYPE

QUANTITY OF INDICATED CABLE TYPE
NOTES:

1. DOOR HARDWARE SUPPLIED AND INSTALLED BY OTHERS (BY PROJECT).

2. PROVIDE SECURITY ACCESS CONTROL COMPONENTS, CARD READERS, DOOR CONTACTS, (GLASS BREAK, BY PROJECT, AS PER UNIVERSITY OF TORONTO SPECIFICATIONS) AND SHALL CONTACT A SALTO CERTIFIED VENDOR OR THE UOFT LOCKSHOP FOR PROCUREMENT OF SECURITY SYSTEM.

3. ALL FIELD DEVICES MOUNTED AND TERMINATED BY ELECTRICAL CONTRACTOR.

4. SECURITY ACCESS CONTROL PANEL SUPPLIED, INSTALLED AND TERMINATIONS BY ELECTRICAL CONTRACTOR AND TESTING, PROGRAMMING & COMMISSIONING BY FACILITIES & SERVICES (F&S).

5. PROVIDE WIRING & CONDUITS FOR THE SECURITY SYSTEM AS SHOWN ON THE DRAWING. COORDINATE WITH U of T LOCK SHOP FOR SECURITY QUERIES, EXACT LOCATION OF FIELD DEVICES AND SECURITY ACCESS CONTROLLER.

6. PROVIDE NEW SECURITY SYSTEM AS SHOWN ON THIS DRAWING. ALL THE SECURITY SYSTEM DEVICES SUCH AS CARD READERS, GLASS BREAK & DOOR CONTACTS SHALL BE INSTALLED & ROUGH-IN BY ELECTRICAL CONTRACTOR. THE ELECTRICAL CONTRACTOR WILL PROVIDE ALL THE NECESSARY CONDUITS & WIRING AS REQUIRED TO MAKE THE SECURITY SYSTEM FULLY FUNCTIONAL. THE SECURITY SYSTEM SHALL BE COMMISSIONED BY F&S. COORDINATE WITH F&S ON SITE.
WORK RESPONSIBILITY

BY ELECTRICAL CONTRACTOR:

1. PROVIDE ALL WIRING, CONDUIT & JUNCTION BOXES.

2. PROVIDE ALL WIRING AS NOTED ON THIS SCHEMATIC. WIRING SHALL BE SOLID COPPER CONDUCTORS, RISER RATED & INSTALLED IN CONDUIT.

BY UofT CONTRACTOR:

1. PROVIDE ALL CARD READERS, DOOR CONTROLLERS, DOOR CONTACTS, RX/LX DEVICES.

2. FINAL CONNECTIONS, PROGRAMMING & COMMISSIONING OF DOOR CONTROL SYSTEM.

BY GENERAL CONTRACTOR:

1. PROVIDE TRANSFER HINGE. REFER TO ARCHITECTURAL DRAWINGS & SPECIFICATION FOR REQUIREMENTS.
DOOR OPERATOR DETAILS
LOCKABLE & ALARMED
WASHROOM DOOR SCHEMATIC
# FIELD DEVICE LEGEND

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO</td>
<td>DOOR OPENER</td>
</tr>
<tr>
<td>•</td>
<td>DOOR ACTIVATION DEVICE</td>
</tr>
<tr>
<td>DL</td>
<td>DOOR LOCK DEVICE (PUSH TO LOCK PLATE SWITCH)</td>
</tr>
<tr>
<td>DR</td>
<td>DOOR RESET BUTTON. PROVIDE LAMACOID PLATE, 1/8” HIGH BLACK LETTERS ON WHITE BACKGROUND TO READ &quot;PRESS TO RESET&quot;.</td>
</tr>
<tr>
<td>ES</td>
<td>ELECTRIC STRIKE</td>
</tr>
<tr>
<td>ASSISTANCE REQUESTED</td>
<td>&quot;ASSISTANCE REQUESTED&quot; SIGN</td>
</tr>
<tr>
<td>ASSISTANCE REQUIRED</td>
<td>&quot;ASSISTANCE REQUIRED&quot; SIGN</td>
</tr>
<tr>
<td></td>
<td>EMERGENCY CALL STRIP. &quot;EMERGENCY ALARM – PRESS FOR ASSISTANCE”. BLACK LETTERING ON YELLOW BACKGROUND. PROVIDE LAMACOID PLATE, 1/4” HIGH RED LETTERS ON WHITE BACKGROUND TO READ, &quot;EMERGENCY PUSH STRIP – USE ONLY IN AN EMERGENCY.” MOUNT LABEL ABOVE EACH PUSH STRIP.</td>
</tr>
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</table>
SEQUENCE OF OPERATION: ACCESSIBLE WASHROOM

- Door activation device opens door.
- Door lock device deactivates exterior door activation device, locks the door & activates the in use sign.
- Interior door activation device unlocks and opens the door & deactivates the in use sign.
- Emergency call strips activate the assistance required sign, the audible buzzer & unlocks the door.
- Door reset button returns the system to normal mode.

NOTES: (ACCESSIBLE WASHROOM)

1. For exact heights, refer to architectural drawings.
2. Low voltage wiring shall be copper conductors.
3. All low voltage wiring shall be stranded & shielded installed in conduit or plenum rated in hollow metal door frame where accessible.
4. Run wires in to header of automatic door operator opposite hinge side above door jamb to allow for organized low voltage wiring due to location of relay.
5. Minimum conduit size to be 3/4".
ASSISTANCE REQUIRED

DO

ASSISTANCE REQUESTED

ES DL DR

3'-0" LONG EMERGENCY STRIPS

DOOR OPERATOR DETAILS

LOCKABLE & ALARMED
WASHROOM DOOR SCHEMATIC
TYPICAL WASHROOM ELECTRICAL LAYOUT
CARPET STANDARD ST. GEORGE CAMPUS – May 2013

This standard is intended to ensure that the University of Toronto buildings are provided the most durable, attractive, and sustainable flooring materials at the lowest possible cost to the institution over time. In this spirit, we have created this living document intended to ensure that the built environment at the St. George campus meets our objectives.

Carpet Performance:

- All carpet type must be moisture impervious structured back tile or structured back roll goods.

- **Texture Appearance Retention Rating (TARR):** Carpet must meet TARR ratings specified below:

<table>
<thead>
<tr>
<th>Traffic Classification</th>
<th>TARR Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>≥ 3.0 TARR</td>
</tr>
<tr>
<td>Heavy</td>
<td>≥ 3.0 TARR</td>
</tr>
<tr>
<td>Severe (including classrooms /lecture halls)</td>
<td>≥ 3.5 TARR</td>
</tr>
</tbody>
</table>

*Note: The rating must be third party evaluated using ASTM D-5252 Hexapod Drum Test as per the commercial carpet test procedure and TARR classification determined using ASTM D-7330.*

- **Tuft Bind:** Minimum 10 lb. average tuft bind for Loop Pile – ASTM D-1335.

- **Static:** for typical use - Less than or equal to 3.5 kV when tested by AATCC Test Method 134 (Step Test Option).

- All carpeting must inhibit bacterial and mould growth.

- All manufacturers must offer warranty that the supplied carpet is free of defects for not less than 2 years from installation date.
Product Sustainability and Environmental Requirements:

- **Carpet must be NSF 140 2007e minimum "gold" level:** A copy of this certification is required for the specific carpet being selected. The carpet manufacturer must supply this certification. 
  

- **Recycled content:** 30% of the total product weight - pre-consumer or post-consumer content or a combination of both.

- **Carpet must be 100% closed loop recyclable:** A certification of this is required. All carpet at the end of its useful life (as determined by the owner) must be removed, transported, and third party certified recycled 100% back into carpet at no cost to the University.

- **Low Emitting Materials:** The carpet and floor adhesive (for glue-down installations) must meet the Green Label Plus (GLP) requirements; and floor adhesive (for direct glue-down) must meet the Carpet and Rug Institute (CRI) requirements. GLP number must be provided. Carpet as well as all installation components including adhesives, sealers, seam welds and seam sealers must meet the Low Emitting Materials Standards as outlined in the U.S. Green Building Council LEED criteria. Adhesives must meet VOC content standards per South Coast Air Quality Management District Rule #1168.

Procurement Considerations:

**This standard is applicable to a minimum carpet purchase amount of $5,000.00 (including supply and installation cost).**

**If new carpet is replacing old carpet:** The manufacturer of the new carpet must remove the existing carpet (regardless of manufacturer) and closed loop recycle (no landfill or waste to heat) at no cost to owner and provide third party certification of this within 30 days of the removal.

**Note:** To meet the University procurement requirements, anyone tendering carpet products for areas anticipated to cost the University over $25k, within a project, must specify and tender a minimum of 3 different manufacturers’ carpets (quotes) that meet the above criteria and are acceptable in appearance to the department.

**All new buildings require permanent entrance matting at all entrance areas:** The carpet needs to be 100% closed loop recyclable as noted above. Lobbies need to have matting sufficient to effectively remove dirt, water, snow and salt at the entrance area.
Matting should extend past the vestibule area (at least 12 feet / 3.66m).


**Classrooms** to have structured back seam welded rolled goods due to their superior sound attenuation and cleanability.

List of manufacturers/suppliers with products that meet this specification include but may not be limited to:

- Interface
- Mannington
- Mohawk
- Shaw
- Tandus
Design Standards
Fire Alarm Systems
Division 13860 (1995 CMS); 283100 (2004 CMS)
Amended Feb 2015
FIRE ALARM SYSTEM

13860 (283100)

The following standard shall be followed for the design of University of Toronto fire alarm systems.

.1 Acceptable manufacturers and model numbers are as follows:
Chubb-Edwards EST-3 series for systems with more than 8 zones or those using addressable devices;
Chubb-Edwards EST-FS fireshield series for systems with 1-8 zones provided building is not sprinklered.
Verify system selection with University of Toronto Fire Prevention during conceptual design stage.

.2 All fire alarm system devices and control units shall be purchased by the Contractor, directly from the manufacturer.

.3 New installations with more than 32 zones shall utilize active field devices, using analog addressable technology. Upgrades or retrofit work shall utilize this technology if budget permits. Data communication links for active field devices shall be configured in a DCLA style as defined by CAN/ULC-S524. System installation shall conform to CAN/ULC-S524.

.4 System Operation: Single stage operation unless otherwise approved by University of Toronto Fire Prevention. Manual signal silence only (no automatic silence feature).

.5 Signalling Appliances
.1 New installations with no OBC-mandated voice requirement: 24VDC, parallel wired horn/strobe, using temporal signal pattern in accordance with OBC – Chubb-Edwards catalog # 757-7A-TW.
.2 Existing installations/renovations: match existing.

.6 Annunciation: Locate main control panel or CACF at the designated Fire Department response point, to be used as the main annunciator. Provide light emitting diode (LED) annunciation of zones (as conventionally defined by the OBC), and liquid crystal display (LCD) annunciation of individual active field devices via the alphanumeric LCD. Provide water shield covers for fire alarm panels in sprinklered areas to protect panel from water damage. Fire Alarm Control Panels shall not be located in mechanical rooms where steam heat piping is present.

.7 Zone and active field device descriptions for annunciation & LCD programming are to be coordinated with and approved by U of T Fire Prevention.

.8 Maglocks are not permitted to be installed in U of T buildings without prior application-specific written approval by University of Toronto Fire Prevention, and will not be accepted otherwise.

.9 Standpipe main flow detection shall annunciate as a supervisory indication only.

.10 Automatic detection in elevator shafts shall be accomplished with heat detectors.

.11 Install automatic detection only in those places where required by OBC.

.12 Use photoelectric type smoke detectors when smoke detection is specifically required by the OBC. Ionization (only) detection shall not be used in University buildings unless approved by U
of T Fire Prevention. Where the code requires fire detectors, giving a choice between heat or smoke detection, heat detectors shall be used.

.13 Use only photoelectric smoke alarms in residences when smoke alarms are required by the OBC.

.14 High temperature, "fixed" type heat detectors shall be used in high temperature areas such as boiler rooms, laundry rooms, rooms equipped with autoclaves, etc., otherwise use rate of rise type heat detection.

.15 Automatic fire detection shall not be installed in washrooms, "cold rooms", or walk-in freezers.

.16 If a floor area is fully sprinklered, heat detectors are not required and shall not be installed within that floor area.

.17 Door hold-open devices are required to release immediately upon activation of the fire alarm system as per OBC 3.1.8.12.

.18 Smoke detection and smoke control measures are required for an interconnected floor space as per OBC 3.2.8.8.

.19 Recirculating air handling units shall meet the requirements for smoke detection only where specifically required by OBC 3.2.4.12. Non-recirculating units shall not be equipped with duct smoke detection. All recirculating air handling units that do not have a smoke control mode shall shut down automatically upon any common fire alarm activation, and will be interconnected in such a way to restart automatically upon fire alarm system restoration to normal.

.20 Emergency power requirements shall be designed to the minimum requirements of OBC 3.2.7.8. If the fire alarm system is connected to an emergency generator, standby batteries shall be included to provide for 2 hours of supervisory power only.

.21 Printers and/or video displays are not desired and will not be accepted by U of T Fire Prevention.

.22 New systems shall be designed and installed as part of the University of Toronto fire alarm central monitoring system, reporting system alarm and system trouble information back to the Central Monitoring location at the Campus Police Station, 21 Sussex Avenue.

.1 Design and installation of the interconnection on site shall be to Chubb-Edwards Systems specifications under the direction of U of T Fire Prevention.

.2 The Contractor shall co-ordinate wiring or fibre runs and tie-in with University of Toronto Computing and Networking Services and University of Toronto Fire Prevention.

.3 The Contractor shall arrange for setup of monitoring connections through the U of T Project Manager at least two weeks prior to the date required for Toronto Fire inspection.

.4 The Contractor shall terminate the required connections for central monitoring in a junction box within 1m of the fire alarm system wallbox where the connection is required to be tied in.

.5 The Contractor shall pre-schedule final system tie-in at least 7 days in advance, with University of Toronto’s Fire Alarm Testing & Maintenance Contractor, who shall make the final connections between the junction box and the control panel and test the circuits. The Contractor shall carry the cost of this work by U of T’s Fire Alarm Testing & Maintenance Contractor.
.22 New EST-3 systems shall include the following common control features (password protected):
- sprinkler test mode switch
- silent test switch
- ancillary bypass switch
- one minute inhibit bypass switch

.23 Beam type smoke detectors shall not be incorporated as a means of smoke detection without prior application-specific written approval from U of T Fire Prevention.

.24 Data Gathering Panels or remote annunciators (distributed intelligence) shall not be used without prior application-specific written approval from U of T Fire Prevention.

3.1 As-Built Drawings

.1 A complete set of as-built drawings shall be compiled and submitted to U of T Fire Prevention, showing locations of all fire alarm devices, conduits, junction boxes, and end of line devices. Drawings shall identify numbers of conductors and zones served, as well as device addresses for addressable systems. The installation will not be accepted until this documentation has been received in full.

3.2 CONDUITS AND WIRING

.1 Fire alarm system conduits shall be identified every 3 metres by a band of red tape or other means deemed acceptable in writing by U of T Fire Prevention. Junction boxes for fire alarm system wiring shall be similarly identified or marked “F/A”. Signal circuit wiring shall be run in a separate conduit from initiating circuit wiring or communication wiring (including active field device wiring).

.2 Where fire alarm junction boxes will normally be inaccessible, properly identified access hatches shall be provided. Locations of access hatches shall be shown on as-built drawings and shall be identifiable in the field by permanently affixed markings to the approval of University of Toronto Fire Prevention.

.3 All conduits shall enter the fire alarm control units from the bottom of the cabinet. Two additional knockouts shall be punched in the bottom of each cabinet, and fitted with a wire mesh screen in order to protect system components from possible water damage that may enter the control panel via conduits. Fire alarm control units shall be protected from sprinkler discharge by adequate drip trays.

3.3 WITNESSING OF FIRE ALARM/SPRINKLER VERIFICATION

.1 All fire alarm system modifications and new installations shall be verified in accordance with the requirements of the Ontario Fire Code. Verification in its entirety shall be witnessed by the University of Toronto’s Fire Alarm Testing & Maintenance Contractor, to help to ensure the integrity of the field verification process. The contractor performing the Work shall include the cost of subcontracting this work in his bid as a separate identified price, and shall schedule the verification with University of Toronto’s Fire Alarm Testing & Maintenance Contractor at least two weeks in advance of its commencement. Verification will not be accepted without a letter of witnessing from the University’s Fire Alarm Testing & Maintenance Contractor. Any exceptions to this requirement shall be authorized in writing, at the discretion of University of Toronto Fire Prevention, acting in the best interests of the University.
Further to sentence 3.3.1, when a relocation, addition, or deletion of a device has been carried out, all devices in the zone shall be tested and documented for proper operation. This applies to both alarm initiating and signal (output) circuits. This testing shall be witnessed as noted in the previous item, and the cost for such shall be included in the Contractor’s bid.
Design Standards
Mechanical – Fire Protection: Division 139xx (1995);
21xxxx(2004)

Amended February 2015
SPRINKLER SYSTEMS

13910 Sprinkler Heads

.1 Concealed sprinklers heads shall not be installed, and will not be accepted.

.2 Semi-recessed sprinkler heads with removable escutcheons shall be installed in all areas having ceiling tiles and drywall ceilings.

.3 A set of six spare sprinklers and escutcheons of each type installed shall be turned over to the University of Toronto Fire Prevention Services. A spare head cabinet is not required.

13915 (211100) Sprinkler Piping

.1 All threaded piping shall be schedule 40 or greater.

.2 “Threadable light wall pipe” shall not be installed, and will not be accepted.

.3 Trim on alarm valves shall be galvanized piping.

.4 Drain lines (two inch main drains, auxiliary drains, drains from inspector’s tests etc.) shall be galvanized piping.

.5 Piping from air compressors to system piping shall be galvanized pipe or soft copper tubing.

.6 Piping used on dry pipe systems shall be a minimum of schedule 40 and shall be galvanized.

.7 All nuts, washers, rod and hangers used in dry pipe systems shall be galvanized.

.8 Excess pressure pumps shall be wired for automatic operation using a Potter control (Potter Part# PCS-300-1B) pressure switch.

.9 Valves two inches and smaller (including valve trim, inspector’s test valves etc.) shall be Watts 6000 series ball valves.

.10 Drains shall not empty into sinks or slop sinks. A dedicated floor or hub drain (properly trapped and vented, with a trap seal primer) is to be provided. A hub drain is preferred.

.11 Alarm valves shall have a minimum of 12 inches clear space around the valves as measured beyond the trim.

.12 Victaulic type couplings used on sprinkler systems shall be of the dry lube style, Victaulic “Vic Plus” Fire Lock 005.
13910  Sprinkler Valves

.1 Alarm check valves for wet systems shall be manufactured Victaulic, series 751.

.1 The use of an alarm check valve on the incoming supply shall be avoided. A Victaulic 717R riser check may be used in place of an alarm valve.

.2 Alarm check valves for dry systems shall be manufactured by Victaulic, series 768.

.3 Control valve assemblies for pre-action or deluge systems shall be prepackaged systems manufactured by Victaulic.

.4 Isolation valves larger than two inch (2”) shall be butterfly valves manufactured by Victaulic.

.5 Normally closed valves shall be Victaulic series 707C or 766 models.

.6 Trim on alarm valves shall be of galvanized material. This requirement extends to the two inch (2”) main drain piping from the alarm valve to the termination point.

.7 The two inch (2”) main drain valve, the trim control, air control, excess pressure pump, inspector’s test valves shall be WATTS #6000 ball valves. Exception: When a combination inspector’s test / drain valve is used it shall be a TESTanDRAIN Model 1000 / AGF Manufacturing Co., Warren N.J. or Model A61 Test and Drain / National Fire Equipment Ltd., complete with pressure gauge. Exception: Drain valves on Victaulic dry and pre-action valves can be as supplied by Victaulic.

.8 The excess pressure pump on a wet system and the compressor on a dry system shall be wired to provide automatic operation. The pump or compressor shall be controlled by a Potter control (Potter Part# PCS-300-1B) pressure switch. The pressure switch shall be located on the system riser above the alarm valve complete with a WATTS #6000 isolation valve.

.9 The excess pressure pump installed on wet systems shall be a minimum of one half (½) horse power and the gear pump shall be high capacity.

.10 All valves shall be marked with permanent, chained tags indicating the area served or purpose of the valve. Descriptions shall match those on the fire alarm system zoning, and shall be subject to the approval of University of Toronto Fire Prevention.

.11 The two inch (2”) main drain from all alarm valves shall be piped to a dedicated hub drain capable of receiving full flow. On a multiple installations the drain lines may be combined and run to a single dedicated hub drain. An acceptance test shall be done before the University accepts the work.
.12 Double check valve back flow devices shall be Watts 757 BFG models or Watts 757 DCDA BFG models depending on City of Toronto requirements.

.13 Reduced pressure principle back flow devices shall be Watts 957 BFG models.

13910 Zone Control Stations

.1 Zone control stations are mandatory.

.2 Zone control stations shall consist of monitored isolation valve, a check valve, a flow switch and a combination inspector’s test / drain valve.

.3 Zone control stations shall be located in the same style of cabinet used for the Standpipe systems.

.4 Zone control stations shall be located in public spaces i.e. above or next to a fire hose cabinet. Zone control stations shall under no circumstances be installed in ceiling spaces, washrooms, janitor’s rooms, change rooms or private offices.

.5 The top of the zone control station cabinet shall be no more than seven feet (7ft.) from floor level.

.6 The drain line from the inspector’s test / drain shall be piped to a dedicated hub drain capable of receiving full flow. On a multi-storey buildings the drain lines on a common sprinkler riser may be combined and run to a single dedicated hub drain. An acceptance test shall be done before the University accepts the work.

.7 The combination inspector’s test / drain valve shall be a TESTanDRAIN Model 1000 / AGF Manufacturing Co., Waren N.J. complete with a pressure gauge.

13915 (211100) DRY PIPE, PRE-ACTION AND DELUGE SYSTEM PIPING

.1 Piping downstream of the alarm check valve shall be schedule 40 galvanized pipe. “Threadable light wall pipe” will not be accepted.

.2 All fittings including Victaulic couplings shall be galvanized.

.3 All Victaulic type couplings used on dry sprinkler systems shall be manufactured by Victaulic and shall have Victaulic grade E, Type A, FlushSeal gaskets.

.4 Victaulic grooves shall be rolled rather than cut.

.5 Piping cut ends and holes cut for saddle tees shall be coated with a galvanized coating.

.6 Black steel piping and welded outlets may be used for branch lines provided the finished product is dipped in galvanized coating.
.7 Drum drips shall be installed with WATTS #6000 ball valves.

.8 Drum drips shall be installed such that the highest valve is no more than seven feet (7ft.) from floor level.

.9 These specifications do not require galvanized sprinkler piping in parking garages to be painted. However, if other specifications require the sprinkler piping to be painted, (i.e. for aesthetic reasons), the piping shall be installed and painted in the following manner. All piping shall be primed with galvanized primer and painted red. This step is to be done only after the system has been installed and the University of Toronto Fire Prevention Services has signed a preliminary acceptance of the piping. The pipe may be pre-painted provided the paint stops twelve inches (12") from each end, fittings may not be pre-painted.

Nitrogen generators shall be supplied for each dry or pre-action system or group of systems. Nitrogen generators to be Potter models.

13910 ANTIFREEZE SYSTEMS

.1 Antifreeze systems shall not be installed. Where an antifreeze system is contemplated, the area shall either be heated, protected with dry pipe sprinkler heads, or a dry pipe system.

13975 (211200) STANDPIPE SYSTEMS

.1 Standpipe systems shall be supplied with isolation, isolation supervision and draining provisions at the base of all risers.

13??? FIRE DEPARTMENT (SIAMESE) CONNECTIONS

.1 Fire Department Connections shall be mounted on the building

.2 No underground piping is permitted for the Fire Department Connections

13910 FIRE PUMPS

.1 Fire pump installations shall have flow test connections run to the outside of the building, terminating at a location approved by the University Fire Prevention Services.

.2 The termination point referred to in 3.7.1 shall be provided with an identification plate similar to the type used for the siamese connection, be provided with the required number
of two and one half (2 ½) inch threaded hose connections (complete with brass caps) to allow for an adequate flow to test the fire pump.

.3 The fire pump test connection shall be controlled by supervised butterfly valve complete with a two inch (2”) Watts #6000 ball valve installed to completely drain the piping from the isolation valve to the test connection. This two inch drain line shall terminate in a dedicated hub drain capable of receiving full flow.

.4 All piping and fittings from the isolation valve to the test connection, including drain lines, shall be schedule forty galvanized pipe.

.5 Fire pumps shall be supplied with mechanical seal construction (no packing permitted).

.6 Fire pumps shall be paired with a jockey pump. Excess pressure pumps shall not be used in place of a jockey pump.

.7 Fire pumps shall be labeled as “Sprinkler Fire Pump” or “Standpipe Fire Pump” on the pump and on the Fire Alarm Panel.

13050 Close-out Documentation

.1 Before the University Fire Prevention Service provides final acceptance of any installation or renovation, three copies of the close-out documentation must be submitted and accepted.

.2 The close-out documents shall be submitted in three ring binder and include the following items;

.1 Warranty on company letterhead, complete with warranty start date, period of warranty, contact names and phone numbers, after hours emergency contact information.
.2 Hydraulic calculations.
.3 NFPA acceptance test reports.
.4 As-built drawings (paper).
.5 As-built drawings (AutoCad).
.6 Specification sheets on each type of sprinkler used in the project.
.7 Specification sheets on each type of isolation valve used in the project.
.8 Specification sheets on each type of switch used in the project.
.9 Specification sheets on any additional equipment used in the project ie. Air dryers, compressors, nitrogen generators.
.10 Alarm valve(s) owner’s manual(s).
.11 Equipment pressure settings i.e. Dry valve trip pressure, jockey pump start up and shut down pressures, fire pump start up pressure.
DIVISION 14 - ELEVATOR DESIGN STANDARDS

1 General
1.1 General Requirements
1.2 References
1.3 Submittals, Samples, Shop Drawings and Manuals
1.4 Warranty Provisions
1.5 Maintenance Provisions
1.6 Appendix E Compliance
1.7 Union Work
1.8 Patents
1.9 Quality Assurance

2 Products - Description of Equipment
2.1 Basic Description of Elevator Equipment
2.2 Card Reader Security Provisions
2.3 CCTV Security Provisions
2.4 Life Safety Provisions – Voice Communication
2.5 Life Safety Provisions – Fire Emergency Operation
2.7 Traction Equipment
2.8 Hydraulic Equipment
2.9 Equipment Guarding
2.10 Car Controllers
2.11 Elevator System Control Features
2.12 Central Monitoring Provisions
2.13 Door Operator, Door Detector and Entrance Equipment
2.14 Cab Enclosure
2.15 Remote Cab Licence Provision
2.16 Wiring
2.17 Materials
2.18 Engraving and Signage
2.19 Proprietary and Prototype Equipment
2.20 Annunciator Panel

3 Execution
3.1 Installation
3.2 Wiring
3.3 Touch Up and Cleaning
3.4 Painting
3.5 Demonstration and Training
SECTION 14 – ELEVATOR DESIGN STANDARDS

1. GENERAL

1.1 General Requirements

1 All elevator work must be performed in accordance with the requirements of the jurisdictional authorities (local, provincial, and federal) in effect at the time of execution.

2 Stainless steel finishes shall be ASTM type 304, brushed or satin finish, X-L Blend S, or X-L Buff finish, to manufacturer’s standard and Designer’s stated choice.

3 Scope of work shall include preparation, filing, stamping, and submission to the Technical Standards and Safety Authority, Elevating Devices Branch of all Design Submissions and filings for each elevating device as provided under this scope of work.

4 Scope of work shall include for arranging and performing acceptance inspection tests for each elevating device, in accordance with the latest regulatory requirements. Conduct all tests in the presence of authorized representatives of such authorities.

1.2 References

1 Elevating devices work shall be designed, fabricated and installed in accordance with the latest edition of the following standards and regulations:

1 B44 Safety code for elevators and escalators, Canadian Standards Association, latest edition.


3 Ontario Regulation 209/01 Elevating Devices, as amended by O. Reg. 252/08.

4 Certification and Training of Elevating Device Mechanics O. Reg. 222/01 as amended by O. Reg. 250/08.

5 Codes and Standards Adopted by Reference O. Reg. 223/01.

6 Occupational Health and Safety Act – R.R.O. 1990 Reg. 851 (Industrial Establishments), specifically sections 13, 14 as they relate to elevator car top guardrails and sections 24, 25, 75 and 75 as they relate to elevator machine room equipment guarding.


Elevating Devices (O. Reg. 209/01).
Canadian Standards Association and Electrical Safety Authority Certification for electrical components.

1.3 Submittals, Samples, Shop Drawings and Manuals

.1 Samples to be submitted for review and approval include;
  .1 Elevator cab and hall signal buttons
  .2 100 x 100 (4” x 4”) square sample of all polished metal materials used in finished work
  .3 Sample of tactile plates used for Barrier Free access markings used for car operating panels and hall landing door frames

.2 Shop Drawings to be submitted for review and approval

  .1 In addition to shop drawings and equipment details as required for formal submission to the regulating authorities, the following details and information shall be prepared and presented to U of T for review and approval as relating to the elevating devices installed:
    .1 Hoistway plan view, section and elevation
    .2 Elevator controller closet plan view and section
    .3 Elevator guide rail bracket support locations, showing vertical distance between adjacent brackets, and location in terms of hoistway footprint.
    .4 Elevator entrance assembly plan view, section and elevation
    .5 Elevator cab interior showing plan view, reflected ceiling plan, front wall elevation, side wall elevation, rear wall elevation, floor plan.
    .6 Elevator cabin enclosure exterior views and elevations
    .7 Hoistway elevation, showing hoistway side of each entrance opening and related hardware
    .8 Elevator signal and fixture drawings.
    .9 Elevator remote panel(s) drawings for CACF location.

.3 Operation and Maintenance Manuals, plus TSSA Submissions and Electrical Drawings

  .1 Provide one hard copy of all the following equipment information. Provide a second copy, saved on an electronic format (i.e. USB memory stick) with all drawings and documents saved in a PDF or Word format.
.1 Description of system control and operation.
.2 Details on equipment features, special operations, and life safety controls.
.3 Details of alarm signals and life safety operation.
.4 As built electrical circuit diagrams.
.5 Equipment parts catalogue.
.6 Maintenance and servicing instructions for door operators, door protective devices, cab fans, cab lighting, voice communication equipment, signals and fixture devices.
.7 Lubrication chart.
.8 Equipment parts listing, including part identification numbers for all components and devices used.
.9 Maintenance and adjusting details for new equipment provided under this Scope of work, including machines and brakes, drive motors, rope grippers, governors, controllers, door operators, door detectors, landing door interlocks, and motor drives.
.10 Equipment maintenance check chart.
.11 Equipment trouble shooting guide and instructions.
.12 As built fixture and signal drawings.
.13 As built layout drawings and equipment drawings.
.14 Instructions for cleaning, maintaining and preserving stainless steel material and surface, including warnings regarding harmful cleaning, maintenance and preserving practices.
.15 Copy of MCP and equipment log sheets. Refer to paragraph .3.5 below for additional information.
.16 Name, address, telephone numbers, and email addresses for major component manufacturers.
.17 Copy of final TSSA Design submission form, signed off and stamped by submitting engineer and TSSA.
.18 Details of equipment warranty coverage and exclusions.
.19 Manual index.
.20 All manual documents which are larger than standard size sheets shall be neatly folded and housed in large envelops or drawing pockets. These documents shall be inserted and housed in each manual binder.

.2 Software and Control System Diagnostics.
.1 System software that contains time out or automatic shut down circuitry, requiring resetting by hand held tool or remote access device, must not be provided.

.2 System software containing automatic shut down of elevator in the event detector dwell interval has been exceeded on three successive stops must not be provided.

.3 Spare copy of all system software, latest version including all updates and revisions as installed shall be handed over to U of T prior to Substantial Completion.

.4 Where diagnostic tools and operational software have a planned limited operational life, or a limited or fixed number of keystroke commands, provide the required means to reset tools, without requiring their return to the elevator installer to correct or reset.

.3 TSSA Design Submission

.1 Provide copy of signed and sealed Design Submission form as reviewed and approved by the TSSA. Copy of this submission shall be included in each copy of the equipment maintenance and operating manuals. Submit a full set of original TSSA design submissions to U of T Project Manager.

.4 Electrical Circuit Drawings and Diagrams

.1 Provide one (1) copy of all electrical circuit drawings and diagrams and mount inside the elevator machine room or controller enclosure space.

.2 Laminate this set and mount to wooden backboard in machine room or controller enclosure space.

.3 Provide additional copy of electrical circuit drawings and insert into each maintenance and operating manual.

.5 Maintenance Control Program (MCP) and Maintenance Log Sheets

.1 Provide copy of MCP as prepared and signed off by the equipment manufacturer and designer, indicating the frequency of required maintenance and the tasks required to be performed as part of long term operational maintenance, based upon ensuring optimized equipment reliability, safety and performance.

.2 MCP shall be designed in accordance with the requirements of B44-10 rule 8.5.1.3.

.3 Provide log sheets for each elevating devices, designed in accordance with the requirements of B44-10 rule 8.6.1.3.1.(f).

.4 Provide equipment call back log and record book for each elevating devices, designed in accordance with the requirements of B44-10 rule 8.6.1.4.2. and 8.6.1.4.3.
1.4 Warranty Provisions

.1 Provide a one (1) year, twelve (12) month warranty covering all equipment and products as installed and provided under this Contract. Any replacement of parts or repairs including call back service during the warranty period will be at no cost to the University.

Service response to a call back shall be provided 24/7/365 days as follows:

A. Entrapment – within 1 hour
B. Single elevator in a building – within 1 hour
C. Disruption in a building with multiple elevators – within 4 hours

The warranty date shall commence on the date of Substantial Completion for the Work.

.2 Upon receiving notice of a defect or deficiency, the Contractor shall immediately correct, within an agreed upon time, at its expense, all work found deficient or defective or being incapacity of or unable to meet the design requirements, performance expectations or other specific operating criteria as established within the Contract Documents.

.3 In the event that the same component, device or piece of equipment is found to fail or prove unreliable in two instances within the Warranty period, and the failure of said device cannot be attributed to faulty maintenance, misuse or unintended use, the elevator installer shall replace all such device components.

.4 Should the Contractor delay or fail to make good items of Work as confirmed by U of T as being deficient during the warranty period, and after being given reasonable time to correct such deficiencies, U of T may arrange to have such defective or deficient work complete by another quality company or by using its own in house resources, and then back charge to the Contractor for all costs incurred to rectify deficient work.

1.5 Maintenance Provisions

.1 Maintenance provisions and requirements for the elevating devices shall be covered under a full services maintenance agreement augmented with the following special requirements as set out herein, and including all the requirements, coverage and provisions as set out in U of T’s Standard Maintenance Contract Section 14 90 00.

.2 “Full service” coverage shall include the following requirements and provisions.

.5 Maintenance shall include for regular service visits, at intervals of not more than

.1 Once every 16 days (twice per month inspections) for overhead gearless traction elevators,
.2 Once every 32 days (once per month inspections) for machineroomless gearless traction elevators,
.3 Once every 32 days (twice per month inspections) for electric traction overhead, basement or offset geared traction elevators,
Once every 32 days (once per month inspections) for hydraulic passenger, service elevators or dumbwaiters).

For call backs occurring outside of normal working times, emergency call backs excepted, U of T will pay the overtime premium portion for labour, except for emergency call backs required for the release of trapped passengers, or in the event that all elevators within any one group are out of operation.

Maintenance coverage shall also include for the following:

1. Replenishment of machine bearing oil (where provided), sealing of bearings and pour spouts to ensure no oil spills over machine base or floor. In the case of geared machines, worm gear case lubricant shall be changed at least once every two years.

2. Operation and control circuits shall be checked for proper operation. Specification performance settings shall be maintained, except when requested in writing by U of T to change such performances.

3. Replacement of all hoist ropes, governor ropes, as well as travelling cables and other hoistway conductors.

4. Adjustment of car operating performances, load weighing settings, door performances, leveling and all other system adjustments shall be periodically checked and readjusted to maintain specified performances.

In the event the maintenance contractor fails to correct noted deficiencies within the stipulated correction time as listed by the TSSA in their periodic inspection report, or, in the event the maintenance contractor fails to submit voluntary compliant documents, or falsely indicates information or details on the voluntary compliance requires, the elevator maintenance contractor shall be responsible for all additional levies, fees and fines as imposed by the TSSA to the U of T.

1.6 Appendix E Compliance

1. This elevator shall be designed in full compliance with B44 Appendix Section E, including the provision of audio voice annunciation.

2. Refer also to U of T Design Standards Barrier Free Accessibility, Section 11 Elevators. All items as listed therein shall be incorporated into the final design of the elevators as provided for each Project.

3. Provide voice annunciation to announce floor number and car intended direction of travel, as well as basic warning messages (i.e. “please clear doors”), to accommodate Barrier Free Access designs. Unit shall announce messages through a speaker grille mounted in the car operating station that does not contain the hands free telephone unit. Annunciation messages shall be given in English, having a noise output strength of at least 10 dBA above ambient, with a maximum output noise level of 80 dBA. Noise output strengths shall be measured at car operating panel’s annunciator
speaker grille.

.4 At the side opposite each landing entrance, provide a reflective surface, suitably located to permit a person in a wheelchair to see behind themselves when backing out of the elevator.

1.7 Union Work

.1 Elevator work shall be undertaken by International Union of Elevator Constructors, Local 50.

1.8 Patents

.1 The Contractor shall be responsible to save and hold harmless U of T for all liability resulting from copyright and/or patent infringement that might arise because of the finished Work as provided.

1.9 Quality Assurance

.1 Under no circumstances will the Contractor provide control and operating systems that requires special time sensitive or command limited service access tools, special or restricted access diagnostic hardware, or involve limited access hardware or software, or otherwise limit or restrict the maintenance options of the Building.

.2 Provide to U of T, all manuals, hardware, software, operating manuals, maintenance instructions and service equipment as required to maintain the elevator control and operating systems in peak condition.

.3 Use of prototype equipment or controller equipment designs having less than three years of proven experience within commercial and institutional buildings will not be allowed.

.4 All elevator work shall be performed by properly trained and skilled EDMA certified and licensed mechanics. These persons shall be direct employees of the elevator installer.

.5 Elevator circuitry that contains automatic shut down commands, or requiring periodic timer or counter resets to ensure continued operation shall not be permitted.

.6 Prior to award of contract, the Contractor will be required to furnish written affidavit that systems provided under this scope of Work contain no such time out, lock out or automatic shut down provisions.

2. PRODUCTS - Description of Equipment

ELEVATOR DESIGN REQUIREMENTS SHALL BE SPECIFIC TO THE FACILITY BEING PLANNED. ELEVATOR PERFORMANCE AND DESIGN SPECIFICS SHALL BE CONFIRMED BY A SPECIALIZED ELEVATOR CONSULTING FIRM, WITH COPIES OF ALL REPORTS, TRAFFIC CALCULATIONS AND DESIGNS USED TO BE FORWARDED TO U OF T FOR THEIR REFERENCE, COMMENT AND RECORD.
2.1 Basic Description of Elevator Equipment

.1 Number – to be confirmed with project specifics
.2 Designations – to be confirmed by project
.3 Number of Entrances – to be determined (tbd)
.4 Entrance Locations – tbd
.5 Vertical Rise: tbd
.6 Machine Room Location – tbd
.7 Type – tbd
.8 Capacity – tbd, except that minimum cab capacity and cabin size shall be 1,590 kg (3,500 lb) / 21 persons, Class A loading. With a clear inside cabin width of 2,030 mm and clear depth of 1,650 mm measured from face of front return wall to the finished face of the rear wall. Passenger elevators shall be designed to accommodate Class A, General Passenger loading, except where required to function as part time service elevator. Full and part time service elevators shall be designed to accommodate Class C3 Concentrated Loading, where the heaviest single piece to be carried is to be 250 kg less than maximum car capacity.
.9 Rated Speed – tbd
.10 Control – AC VVVF for traction, AC Single speed with soft start for hydraulic applications. [GREEN or LEED standard provision]
.11 Operation – Full Selective Collective
.12 Operating Features
  .1 Independent Service
  .2 Card Reader Security Provisions, including floor tracking
  .3 Fire fighters’ Emergency Operation, Phase 1 and 2
  .4 Load weighing dispatch and bypass where multiple cars are provided
  .5 Cabling for CCTV camera
.13 Entrance Type – Horizontal Slide, Centre Opening (to be used in heavier trafficked applications) or Horizontal Slide, Single Section (to be used in other passenger trafficked applications). For service elevators doors shall be Horizontal Slide, Two Speed.
.14 Entrance Size – tbd, but minimum clear opening width shall be 1,070 mm.
.15 Entrance Frames – tbd
.16 Door Operator – GAL MOVFR or equivalent
.17 Provide car and counterweight roller guides as opposed to lubricated slippers. Provide equalizing springs to facilitate tension adjustments. [GREEN or LEED standard provision]
.18 Door Protection – Multi beam infra red detector – use of 3D sensor feature will not be accepted. Automatic shut down of elevator following three successive nudging applications will not be accepted. Use Adams Gatekeeper or Janus PanaForty type detectors.

.19 Signals and Fixtures

.1 Where Hall lanterns are used, they shall be designed to allow for 180 degree viewing of car direction indicator. Lanterns to have dual stroke tone with adjustable volume control at each fixture.

.2 Digital floor indicators shall be provided at primary lobby landing (mandatory), and at all other landings (desired). Indicators shall display car position in digital display having character heights of no less than 50 mm. Beside floor display numbers, provide arrow to show respective direction of car travel.

.3 Battery power cab lighting, with one flush-mounted fixture set within each car operating panel. Provide test facility within car service cabinet.

.4 Two speed cab ventilation fan, with fan remotely located on car crosshead.

.5 Number of car operating panels (tbd)

.6 One position indicator per panel located at top of panel.

.7 Hands free two way voice communication speaker/microphone mounted behind perforations in the main car operating station.

.8 Flush mounted service cabinet within one car operating panel.

.9 Card reader device mounted in one panel, reader not by Division 14.

.10 Car call buttons to be US 91 BB Series, complete with dual light illumination. Hall call buttons to illuminate green to indicate UP calls and red for DOWN. All car and hall call button illuminations to be LED type.

.20 Associated Dimensions

.1 Hoistway Dimensions: tbd.

.2 Overhead – tbd.

.3 Pit Depth – tbd.

.4 Machine room size – tbd.

.5 Machine room location – tbd.

.6 Cab Dimensions: tbd.

.21 Elevator Cab Interior Finishes

.1 To be determined by Project designer. However, the following minimums must be provided:

.2 Textured stainless steel cladding of inside face of car door panels and front return walls (pattern 5WL or equivalent).
.3 Minimum 2,440 mm (8 feet) clear inside cabin height beneath suspended ceiling.

.4 Polished metal handrails running along the full length of each cab non access wall. Return ends of handrails back in to face the adjacent cab wall so as to eliminate possible snag hazard. Where possible use flat bar handrails as opposed to tubular design. Where flat bar handrails are provided, they shall be of solid metal construction, without wood or composite core.

.5 Finished cab floor shall be installed so it is flush with the top of the car landing sills. No protections or recesses permitted.

.6 Cab lighting and fan shall be designed to automatically turn off during periods of inactivity. Arrange circuits to automatically energize once a call demand has been actuated. [GREEN or LEED standard provision]

.7 Joints between the edge of the finished floor and the cab wall sections shall be sealed with water proof sealant to prevent water from getting to the plywood subfloor below.

.8 Provide each cab with stainless steel button pad hooks, designed to accommodate the hanging of protective mats inside the car. Hooks shall be mounted off the front, rear and both side walls.

.9 Provide one set of cab protective wall mats, for each side wall, rear wall, both front return walls and car transom. Front return panel sections shall have cut out for car panels.

2.2 Card Reader Security Provisions

.1 All elevators to be equipped with card reader access restrictions. Design elevator controls to accommodate these provisions.

.2 Provision of card reader devices and security controller is not the responsibility of the elevator section. However, the elevator installer shall be responsible to hook up and connect card reader devices to be mounted behind the car operating panels.

.3 Include provision for card reader device to be mounted within one car operating panel within each car. Provide in the faceplate of the car panel a lexan lens, coordinate size with security trade, behind which the proximity reader device will be mounted.

.4 Shielded wiring required for card readers shall be run between elevator machine room and car operating panel without breaks, splices, patches or joined connections.

.5 Design elevator controller with necessary circuits to allow for security card reader operation as follows:

.1 Security system master controller as provided by security trade will control activation of security operation.

.2 Under security mode of operation, elevator shall respond to registered hall landing calls plus Main Lobby landing car calls without restrictions.
.3 All remaining car calls, excluding Main Lobby landing, shall only be capable of registration only when a call demand is placed in combination with the presentation of an authorised security access card.

.4 Registered car calls, once cleared by the security master controller, shall be made self-holding until the car stops at that landing.

.5 Provide all circuits and controls to make car calls self-holding after car call clearance has been issued from security master controller and car call has been registered.

.6 Activation of Fire Emergency Operation shall automatically over ride all security system access restrictions.

.6 Provide a dry contact for each car call (including Main Lobby landing).

.7 Provide controls with adjustable time delay, initially set between 2 and 3 seconds, to allow a person to register their landing call demand after having their access card approved for car call registration.

.8 All car call circuits shall be isolated to prevent electrical feedback through interconnections with security card reader controls.

.9 Provide a two position keyed switch, mounted on the exterior of each car controller. Label key switch "SECURITY SYSTEM OVER RIDE". When key is turned to OFF position, complete security control, as determined by the security master controller shall remain in effect. When the switch is turned to its ON position, all security signals, instructions and interfaces with the security system shall be interrupted. Under this mode, the elevator will operate completely independent of the security master controller, with no access restrictions of any kind.

.10 For a multiple car group of elevators, provide in the elevator machine room a master group control two position key switch labelled "SECURITY SYSTEM OVER RIDE". When this key switch is turned to its OFF position, complete security control, as determined by the security master controller shall remain in effect. When this key switch is turned to its ON position, all security signals, instructions and interfaces with the security system shall be interrupted to all elevators operating within that group. Under this mode, all elevators within the group will operate completely independent of the security master controller, having no access restrictions of any kind.

.11 Provision of card reader security system, including master controller, card reader device, relay interface controller, power supplies for the card reader, security system controllers and other related devices shall not be the responsibility of the elevator section.

.12 Elevator section shall provide all required signal interconnections and wiring interfaces for card reader security equipment as well as the installation and interconnection of card reader devices within the new car operating panels.

2.3 CCTV Security Provisions
1. Provide each elevator with one coaxial cable (Beldon Type RG6), plus four shielded cables, #20 AWG for U of T’s exclusive use for closed circuit television monitoring equipment.

2. Terminate cables in elevator machine room within a junction box or terminal strip mounted in the controller, clearly designating these cables as for CCTV use.

3. Provide metal electrical junction box, sized no less than 300 mm square, mounted at the left or right rear corner of each elevator car top. Provide terminal strip in box and bring to terminal strip two pair #14 AWG conductors, clearly marked and feed from a 120 volt AC power supply. Mark outside cover of box with “CCTV”. Terminal traveling cable coaxial and shielded conductors set aside for CCTV use in this junction box. Leave a coiled loop of no less than 2 metres of cabling to allow for the interconnection with the in car CCTV camera. Provision of camera is not the responsibility of the elevator section.

4. Shielded and coaxial wiring shall be run between elevator machine room and car operating panel without breaks, splices, patches or joined connections.

2.4 Life Safety Provisions - Voice Communication

1. Provide hands free telephone with re-programmable auto dialler, set up to allow 10-digit dialling. Unit shall be Webb Electronics Inc. model OEM-150.

2. Telephone unit shall be capable of making outgoing calls and receiving incoming calls. Incoming calls shall not require in-car activation of telephone unit in order to initiate communication.

3. Provide mechanically activated push button to activate telephone. Push button shall be distinct from car operating and floor call buttons and shall be identified with engraved signage reading “PHONE”, along with operating instructions. Operating instructions shall be engraved on top car operating panel, adjacent to hands free phone unit.

4. Telephone unit shall be contained within Car Operating Panel. Speaker grille and microphone shall be located behind perforated grille made in the surface of the car operating panel. A separate faceplate for the telephone unit will not be permitted. Provide illuminating LED indicator designed to show when two way voice communication has been established.

5. Telephone shall initially be programmed to ring through to U of T’s security police desk/reception. Number to be confirmed prior to hand over of first modernised elevator.

6. No visible fastenings, mounting devices or components, other than speaker/microphone grille and activation button shall be visible from inside the elevator cab when the car station panel is in its closed position.

7. In car phone unit shall be capable of receiving incoming calls from an outside line and the Main Lobby Rescue Station handset.
.8 Provide a Main Lobby Rescue Station to be located at either building EVAC panel or CACF room location, or as directed by Project Manager. This Station shall be provided with a handset capable of communicating with each elevator within the complex. Rescue Station shall be provided with engraved signage providing instructions on the use and operation of its handset controls.

.9 Bell phone line and 120 VAC power supply will be brought to the Rescue Station location by trades other than the elevator section.

.10 Main Lobby Rescue Station units shall be similar to Webb Electronics Model LS-250 Lobby Station, with phone cabinet housing and phone handset access door to be finished in stainless steel.

.11 Provision of signal wiring running from Rescue Station to each elevator cab shall be the responsibility of the elevator section, with remote sections of wiring running outside the hoistway installed by the electrical section, through interconnecting conduit provided by the electrical section.

2.5 Life Safety Provisions – Fire Emergency Operation

.1 Provide elevators with automatic Fire Emergency Operation (FEO) in accordance with the latest edition of the Elevator Safety Code Clause 2.27.

.2 Designation of a red hat fire fighters car to be provided where required by Ontario Building Code.

.3 At Primary recall level provide 75 mm high car designation numbers for each elevator.

.4 Primary recall level shall be designated as the main landing into which first responders arrive into the Building (normally the Ground floor lobby).

.5 Alternate recall level shall be the first fire separated landing located above the primary recall lobby.

.6 Provide controls and wiring interfaces to accept and recognize two different recall signals.

.1 Primary recall – initiated automatically by fire alarm system or manual recall initiated by key switch located in the primary recall lobby elevator hall call station. Once activated, this recall mode shall cause elevators to return to the primary recall lobby.

.2 Alternative level recall – initiated automatically by smoke detector device located within the primary recall landing’s elevator lobby. Once activated, this recall mode shall cause elevators to return to the defined alternative lobby.

.3 Elevator Machine Room/Hoistway/Pit space – signal circuits to elevator controls when activated in car fire service annunciator light shall flash to indicate activation of elevator space fire alarm sensor. IN the event the machine room is located at the primary recall landing, or, in the event the elevator pit is located immediately below the primary recall lobby, then
activation of either of these sensors must cause car to recall to its alternative landing.

.7 At CACF panel or at Annunciator panel location, provide second or remote Phase 1 recall key switch. Interconnecting wiring between this remote panel and each elevator hoistway to be supplied by Division 14 trade, while installation if outside the hoistway to be done by Division 16 through interconnecting conduit as provided by Division 16. Division 14 trade shall terminate wiring interconnections at remote panel location.

.8 Provide each elevator cab with one fire service cabinet, containing all controls, signals, engraving and signage in accordance with requirements as set out in B44-047 Clause 2.27.3.3.7 and Figure 2.27.3.3.7.

.9 Provide engraved signage as required by B44 Code for all Phase 1 key switches as well as all in car (Phase 2) switches. Engraving shall be set into fixture faceplate (both primary level lobby hall station and remote panel) and on inside face of fire service control cabinet door (Phase 2 signage). Do not use applied plaques or plates containing such signage.

.10 Provide key switch lock box to house spare FEO-K1 keys, and mount in CACF room or in alternative location as defined by Project Manager.

2.6 Life Safety Provisions - Emergency Power Operation

.1 Elevators shall be provided with emergency power operation.

.2 Where three phase standby power is available, connect to elevators. Elevator controls to be provided with automatic sequencing controls designed to restrict the operation of cars under standby power so that only one elevator per group (or other defined combination as determined during design review) will run under standby power at any one time. Provide re-selection key switch controls, and mount in hall landing call station button fixture as located at primary recall lobby landing.

.3 In the event three phase emergency power is not available, elevators to be provided with stand alone UPS provisions, designed to allow the car to drift (in the case of traction elevators) or lower (for hydraulic units) to a landing. Upon arrival at this landing, car doors shall automatically open, allowing trapped passengers to vacate the cabin enclosure.

.4 Where three phase emergency power is available provide emergency power warning light in primary level recall landing lobby call station and also at the remote elevator panel (CACF room or EVAC panel location). Light to illuminate whenever power is from the Building’s standby system.

2.7 Traction Equipment

.1 In high traffic locations, provide equipment designed to accommodate a minimum of 240 motor starts per hour. Do not use components or equipment designs that are rated only for 180 motor starts per hour.
.2 In location where moderate to light traffic is expected use, where ever possible
machineroomless electric traction drives as opposed to electric hydraulic.

.3 All electric traction units to be provided with variable voltage, variable frequency
drives, complete with re-generative power provisions on installations being installed
within new facilities. [GREEN or LEED standard provision]

.4 Provide tuned choke coils to effectively isolate objectionable and disruptive
harmonics from entering the Building’s power supply. Provide a drive isolation
transformer to reduce power line notching and distortion. Provide harmonic filters to
limit harmonic contribution to under 3% and harmonic distortion to less than 5%.

.5 Equip drive with protection against loss of tachometer signal, tachometer error signal,
over speed, over current, overheat, low voltage, loss of feedback circuit and failure of
brake lift. Control shall be provided with an automatic monitoring circuit that will
cause an elevator to shut down in the event its rated speed under inspection or car top
operation exceeds 0.76 mps (150 fpm).

.6 Drive control cabinets and mountings shall be isolated to prevent vibrations from
disrupting elevator car control circuits, as well as protection against noise
transmission into the Building's structure.

.7 Provide drive controller with means of dissipating heat build up, without affecting
other elevator equipment. Where control cabinets are provided with grilles, vents, or
forced ventilation, ventilation openings shall be provided with filters.

.8 Provide solid state microprocessor based, high performance digital drive control and
programmable distributed logic EEPROM circuitry. System shall be capable of
providing a speed regulation performance of ±1% or better. Controls shall use digital
circuitry to allow for field adjusting of individual performance parameters such as
acceleration rate, deceleration rate, and jerk rate. Performance settings shall be
stored on EEPROMs in non-volatile memory.

.9 Provide pre-torquing of drive motor to eliminate “roll back.”

.10 Provide equipment that can tolerate a voltage fluctuation of +/- 10% without resulting
in car shut down or erratic performance.

.11 Provide equipment that can tolerate a current fluctuation of +/- 5% without resulting
in car shut down or erratic performance.

2.8 Hydraulic Equipment

.1 Provide power units rated to accommodate a minimum of 90 motor starts per hour.

.2 Provide submersible power units, with drive motor and pump located within the same
enclosure that serves as the oil reservoir.

.3 Do not install valve unit over oil reservoir within protective mesh or screen to capture
components that might fall out from the value during servicing,

.4 Provide hydraulic valves as manufactured by Maxton or EECO. Do not provide
valve designs from other manufacturers.
.5 Oil lines shall be provided with pipe stands, and each pipe stand shall be isolated from building structure. Oil pipe shall be isolated from pipe stands.

.6 Provide gate valve adjacent to oil tank in the machine room and provide another gate valve in the elevator pit, adjacent to cylinder.

.7 Provide oil line with isolation fittings, strainer, and muffler.

.8 Use twin post, holeless hydraulic jacks, with single stage piston wherever possible. Use of in ground hydraulic jacks are to be avoided. [GREEN or LEED standard provision]

.9 Do not use jack design requiring the use of piston stabilizers.

.10 Jacks to be installed plumb and aligned with car guide rail columns.

.11 At the top of each hoistway, provide permanently installed steel I beam designed to accommodate the safe hoisting requirements as defined by the elevator installer. Provision of this beam is not the responsibility of the elevator installer.

2.9 Equipment Guarding

.1 Provide in accessible elevator machine room spaces with equipment protective guarding to protect against accidental contact of all rotating and moving components as well exposure to high voltage electrical studs, terminals or lugs. Guarding shall be designed and provided to satisfy the requirements of O. Reg. 851 sections 24, 25, 75 and 76.

.2 Provide at the top of each elevator cab, protective railings and toe boards, designed in accordance with the requirements of O. Reg. 851 sections 13 and 14, as well as TSS Director’s Safety Order 245/10, running along the full length of exposed sides having more than 300 mm horizontal clearance between the edge of the car top and adjacent hoistway construction.

.3 Provide protective pads to protect against chaffing and impact damage of elevator travelling cables. Install this protection on all surfaces throughout the hoistway including divider beams, brackets, pit access ladders and other construction that may come in contact with traveling cables during the motion or movement of the elevator cab.

.4 Within elevator machine room spaces, provide guarding of holes in floor slabs provided to permit the passage of hoist ropes, governor ropes or car positioning tape.

2.10 Car Controllers

.1 Provide car controllers designed and equipped with programmable logic microprocessor controls and self-diagnosing features.

Acceptable Controllers:

Motion Control Engineering MCE – ibox (preferred)
Galaxy – GAL

.2 Control and operating circuits shall use EEPROM chips to allow for onsite
modifications and changes without requiring new chips, off site programming or hard wiring of circuits.

.3 Only generic car controller designs shall be provided. Do not provide or use proprietary controller designs, or controller designs where access to spare parts or engineering assets is limited or restricted.

.4 Design controllers to include all features as noted herein.

.1 Controller cabinets shall be floor or wall mounted. They shall have self-supporting steel structures, and be provided with hinged access doors. Cabinets shall be ventilated, with ventilation slots and openings provided with air filters where forced ventilation is used.

.2 Equip high voltage terminals and lugs with protective means to guard against accidental contact and exposure.

.3 Floor mounted controllers or controller mounting stands shall be secured to the floor.

.4 Controller cabinet doors shall be provided with ground strap.

.5 Mount high voltage devices and resistors away from printed circuit boards and other low voltage solid-state devices.

.6 Provide electrical noise suppression devices in all input and outputs for solid-state circuits as well as all power supplies.

.7 Where enclosed or encapsulated relays are used, provide an LED indicator status light to illuminate when the relay is energized.

.8 Provide each controller with means to show car position. Means may consist of CRT screen, LED indicator or digital fluorescent display.

.9 Solid-state cards shall be equipped with edge connectors to allow for quick removal and replacement. Card slots shall include mechanical keyways and locks to ensure proper and secure seating of all printed circuit cards.

.10 Where multiple connectors terminate at printed circuit cards, provide wiring harnesses.

.11 All circuits containing volatile memory shall be provided with battery backup.

.12 Controllers shall be provided with interface provisions to accommodate card reader access security.

2.11 Elevator System Control Features

1. Provide new microprocessor based selective collective automatic operation to fully coordinate and control elevator car movement and dispatching.

2. Group control system shall use synchronous data link control protocol or local network to ensure error free communications between system control modules and elements.
3. Group dispatching systems shall include specific control programs for UP and DOWN peak operations, as well as for periods of light/intermittent traffic and balanced and heavy two way traffic.

4. Control programmes shall automatic select appropriate group response, based upon real time passenger activities ad car loadings. In addition, provide time clocks for automatic initiation of UP and DOWN peak control programmes.

5. Provide elevators with the following control features and options:
   1. Dispatching controller shall select the elevator best able to respond to a hall landing call, based upon real time operating data. Car selection shall be based upon car location, direction or travel, door status, car load, car call already registered for that landing, number of registered car calls, previous hall call assignments. Preference shall always be given to an elevator already at that landing, or an elevator with a registered car call for that same landing, or the closest available elevator that is running in group operation.
   2. Assign registered hall calls to the other group elevators when a landing call occurs "behind" an elevator.
   3. If an elevator fails to depart from a floor, within an adjustable period of time that is initially set at 25 seconds, automatically disconnect that elevator from group service, and all hall landing calls to be re-registered at that landing. Subsequent hall calls shall not be responded to by the elevator sitting at that floor, unless the problem that has caused the car to time out has been resolved.
   4. Assign one elevator to sit at the primary landing, during periods of inactivity. Only the designated “next up” car shall park at this Lobby. At all landings, parked cars shall only open their doors in response to a registered hall landing call.
   5. Whenever a car without registered car calls arrives at a floor where both up and down hall calls are registered, the car shall initially respond to the hall call for the direction in which it has been travelling. If there is no hall call registered for the direction in which the car has been travelling, the car shall close its doors and immediately reopen them in response to the hall call in the opposite direction. In car directional indicators shall always indicate the direction change when the doors reopen.
   6. A car arriving at a floor to park shall not open its doors, nor illuminate or annunciate its directional indicator.
   7. Cars shall always activate directional indicators whenever stopping at a landing in answer to either a hall landing or car call, unless the elevator is being operated under independent service, inspection operation, or has been designated to park.
   8. Provide independent service feature to allow car to be removed from normal service and respond to car calls only. Once activated, automatic door closing and door dwell times shall be cut out, hall lanterns shall not operate and
registered car calls shall be cleared. Once activated, momentary pressure of car call button shall register call demand. Door closure shall be controlled by constant pressure on either car call button or DOOR CLOSE button. Upon arrival at that landing, car doors shall automatically open and remain open until doors are closed in manner as described above or car is returned to normal operation. Activation of Independent Service shall be controlled by two position keyed switch mounted in car operating panel.

9. Upon arrival at terminal landing, registered car calls shall extinguish. Alternatively, prevent car calls for landings "behind" current car location, from being registered.

10. Provide each car with the following load weighing provisions:
   .1 Initiate whenever the car load reaches a pre-determined fixed percentage of its rated capacity.
   .2 Once activated, load weighting shall cause the car to bypass hall calls until such time as its load is reduced to less that the threshold for this operation.
   .3 Response to car calls shall not be affected.
   .4 Loading weighing shall be provided for dispatch (set at 50% of rated car load) and hall call bypass (set at 40% of rated car load).
   .5 Each load weighing operation shall be independently adjustable, between 0 and 100% of rated car load.
   .6 Load weighing devices may be under car platform sensors or strain gauges, crosshead strain gauges or load cells, or rope hitch transducers.

11. Provide anti-nuisance operation, designed to clear or cancel registered car calls, if a disproportionate number of calls are registered that exceed the car's measured load. Anti nuisance feature may be activated by photo eyes or load weighing.

12. Provide light and fan control circuit to extinguish power to cab lighting and fan during periods of elevator inactivity. Activation time shall be field adjustable. Once actuated, cab lights and fan shall turn off, but shall immediately reactive upon car being assigned new landing call demand. During period when lights are cut out, car call buttons, alarm bell, phone, and door open buttons shall remain operative and fully functional. [GREEN or LEED standard provision]

13. Provide nudging operation that will cause a buzzer mounted on top of the elevator cab to sound in the event the door protective device is activated for more than 20 seconds.
   .1 Buzzer shall continue to sound throughout the entire closing process.
   .2 Doors shall close at a reduced speed, calculated upon actual car door mass.
.3 Nudging feature shall be rendered inoperative when the elevator is operating under independent service.

.4 Control circuitry that automatically causes the elevator to shut down, requiring manual reset, following three successive nudging activations, shall not be permitted.

14. Do not provide door pre-open feature.

6. Elevator group supervisory system shall be a software based, programmable logic micro computer. The computer system shall monitor system demands, coordinate car assignments and dispatch elevators so as to provide the most efficient service to both the riding and waiting passengers. Only one elevator at a time shall be selected to respond to a hall landing demand, and priority shall be given to an elevator that is already travelling in the direction of that call, or an elevator that already has a registered car call for that landing, or a running car. Do not assign further cars to a hall landing call unless it is determined a more efficient response can be achieved, or in the event the designated response elevator fails to or otherwise cannot complete its assignment.

7. Control parameters shall be capable of site adjustments using diagnostic tools and EEPROMs.

8. Group controller shall include fixed dispatching routines for UP PEAK, DOWN PEAK and LIGHT TRAFFIC.

1. UP PEAK operation shall be activated by time clock and by an adjustable number of consecutive cars which are departing from the lobby with car loadings in excess of 50% rated capacity. UP PEAK shall be retained for an adjustable periods after traffic demands ease. During UP PEAK operation, empty or free elevators shall return nonstop to the Lobby landing lobby. No elevator shall be assigned to park at an upper lobby level as long as UP PEAK operation is in effect. During UP PEAK operation, only one elevator at a time shall be permitted to park with its doors open and "next up" lantern lit. Response to DOWN landing calls shall not be ignored during UP PEAK. DOWN calls shall be responded to in the most efficient manner, as determined by the group controller, though priority shall be given to UP calls.

2. DOWN PEAK operations shall be activated by time clock and by an adjustable number of consecutive elevators alighting passengers at Lobby, where the number of passengers exiting are equal to or more than 50% rated car carrying capacity. DOWN PEAK operation shall be maintained as long as traffic conditions warrant, or as long as the time clock is set for. During DOWN PEAK, no unassigned elevator or empty car shall be permitted to park at the Lobby landing. During this operation, elevators shall be dispatched to the highest registered hall landing call, or to a long wait call.

3. Under LIGHT TRAFFIC, one elevator shall be dispatched to park at Lobby. The remaining elevators shall either park at their last landing or car call assignment, or be dispatched in advance of an anticipated hall demand at
some above Lobby landing. Equip controller with the ability to programme designated parking floors at which one elevator is to be parked at during LIGHT TRAFFIC.

9. Provide dispatch failure protection that will automatically force elevators to continue to stop for hall landings, whenever the normal means of dispatching has failed.

10. All time clock devices, as used to initiate and control UP and DOWN PEAK operations shall be independently adjustable. Use only solid state clocks, with 7 day, 24 hour timer. One timer may be used to control both UP and DOWN PEAK functions. Timers shall be equipped with means to bypass weekends. Provide clock timers with battery back up and ready means of adjusting time and control settings as well as incorporating automatic updates and changes arising from switch over from Eastern Standard Time to Eastern Daylight Savings Time and back again.

11. Equip group operating controls with means to learn actual Building traffic patterns are react pro-actively in response to clear and defined trends. Such “artificial intelligence” or “fuzzy logic” systems shall be based upon latest program version, and shall be designed to suit the specific size and nature of the elevator group parameters.

12. Independent software-based, programmable microprocessors or microcomputers shall be used to control elevator group and individual car operations. Systems shall monitor traffic demands, coordinate car assignment and dispatch elevators to minimize passenger-waiting times.

13. Provide remote control monitoring provisions where multiple cars are provided. See Article 2.12 below for additional details.

### 2.12 Central Monitoring Provisions

1. The requirements of this article apply to where multiple elevators are being provided within the same building. The requirements of this article do not apply to an installation where a single lift or elevating device is to be provided.

2. Provide central monitoring system (CMS) information elevator management monitoring system to allow for interactive, real time remote monitoring and control, as well as archival and operating data retrieval. This system shall allow for remote monitoring and control of all elevators. Central monitoring equipment shall be able to control and display operating information for all elevator groups on the same computer screen.

3. Provide one monitor for information display and mount in the Building, within an office or secure location as confirmed by U of T.

4. Cabling required to interconnect all devices and controls for the CMS is the responsibility of the elevator installer. Electrical section shall install wiring between hoistways and remote location of the CMS station, with wiring running through conduit provided under the electrical trade’s scope of work.

5. Provide monitoring unit, the following computer hardware and associated equipment:
1. 533 mm flat screen colour monitor

2. IBM compatible CPU with dual core Pentium processors complete with 1G RAM and 500+ G byte hard drive

3. Provide CPU with:
   .1 One serial port
   .2 One parallel port
   .3 Three USB ports
   .4 Writeable CD/DVD ROM drive
   .5 Graphics card to support flat screen monitor
   .6 Colour laser printer, complete with parallel cable connections and compatible with Microsoft Windows7 or XP Professional operating software.
   .7 Three button wireless mouse
   .8 Wireless keyboard
   .9 V90 Modem

4. CMS shall be designed and accommodate Microsoft Windows operating system and shall allow qualified users to monitor and assess real time elevator performance information and data in various formats and screen presentations, including graphic and data tabulation formats.

5. CMS shall run Microsoft Windows7 or XP Professional software. User interface shall be as per other Windows7 based programmes. When connected on-line, the CMS shall display simulated hoistway and car configurations, with real time elevator operating information such as car position, door conditions, direction of travel, registered car calls, registered up and down landing calls, elevator status, elevator alarm condition, group operation setting (i.e. UP peak, DOWN peak, TWO WAY peak, intermittent), time of day, date, and emergency operation conditions.

6. CMS shall be capable of displaying a variety of system output screens; each fully formatted showing specific details for each elevator, as well as the group status, plus emergency conditions such as fire, emergency power, voice communication and security operations.

7. Screen displays shall be controlled by keyboard entries, as well as password or other security access provisions.

8. System shall enable the display of the following parameters from the remote terminal location:
   .1 Parking floors
   .2 Hall call propriety times
   .3 Car call registrations
.4 Group operating modes
.5 Nudging operation
.6 Car out of service
.7 Door opening
.8 Door closing
.9 Car on independent service
.10 Car off independent service
.11 Car to lobby return
.12 Car out of service
.13 Lobby lock out - per floor
.14 Lock out – per car
.15 Lobby unlock - per floor

4. CMS shall also be capable of providing archival data records for group and individual elevators. Report information shall include:

.1 Average waiting time for up direction landing calls
.2 Average waiting time for down direction landing calls
.3 Average waiting time for all landing calls
.4 Number of registered up direction landing calls
.5 Number of registered down direction landing calls
.6 Number of registered landing calls for both directions of travel
.7 Elevator faults and diagnostic records, per car
.8 Diagnostic records and fault logs for the group
.9 Hall call response times in 15 second increments per direction and total
.10 Average hall call response times per direction and total
.11 Number of calls registered per landing per direction
.12 Average waiting time per landing, per direction of calls and total
.13 Percentage of up to down calls
.14 Hall call distribution
.15 Safety circuit faults
.16 Emergency operations (i.e. fire service and emergency power)
.17 Instances of power fluctuation problems
.18 Number of cars in normal group service
2.13 Door Operator, Door Detector and Entrance Equipment

.1 Provide GAL MOVFR operators.
.2 Provide GAL hall landing door interlock and pick up assemblies.
.3 Provide GAL car door restrictor device and car door clutch.
.4 Provide GAL car door gate switch.
.5 Provide car door with new electronic, infra red multi beam detector extending the approximate full height of the door. Acceptable detectors shall be limited to the following:
   .1 Adams Gatekeeper Max
   .2 Pana-80
.6 Where door detector has 3D sensing feature, set up and adjust door detector so that this feature is deactivated.
.7 Protective device shall be designed to project a multiple beam array of invisible light paths across more than 90% of the clear car door opening.
.8 Operation of the door protective device shall be motionless and noiseless.
.9 Door detector unit shall be provided with nudging feature.
.10 Provide detector unit with audible annunciator. Annunciator shall sound whenever a light beam is disrupted. Operation of annunciator shall be controlled by dipswitch or other adjusting means so that U of T may decide to silence annunciator (except under nudging operation).
.11 Adjust detector to time out whenever device is interrupted for period in excess of 20 seconds.
.12 When indicator is timed out, arrange operator to close doors under reduced torque. Provide loud warning buzzer, mounted on car, to sound whenever doors are closing independent of detector unit.
.13 On elevators designed to accommodate Class C3 concentrated loading, provide suitable structural supports for landing sills, designed to accommodate anticipated heaviest single piece load without permanently deflecting or deforming the sill.
.14 Provide in each landing door panel a means of unlocking the landing door from the hoistway side, when the elevator cab is not at that landing. Means to consist of lunar key device, suitable to function with GAL landing door interlocks. Provide stainless steel ferrule in all openings to span gap between landing door panel skins.

2.14 Cab Enclosure

.1 Cab enclosure finishes to be of durable construction and resistant to scratches and vandalism.
.2 Car door panels shall be clad in textured polished metal, pattern 5WL. Leading edge of each door panel shall be provided with binder strip or metal cladding shall be
wrapped around leading edge of door panel and return 25 mm along the hoistway side of the panel.

.3 Cab flooring shall be of resilient construction. Where tiles are used, provide a minimum of 10% spares for U of T’s “attic stock”.

.4 For service elevators, car sill shall be nickel silver. For passenger cars, extruded aluminum sills may be used, except where aesthetics call for use of bronze sills to match cabin interiors.

.5 Cab lighting, where down lights are used shall use multi cluster LED bulbs. Do not use halogen or incandescent or CFL type lamps. Where strip lights are used, provide LED rope lighting in lieu of fluorescent lamps.

.6 Where down lighting is used, include for dimmer switch in car panel to control lighting intensity within the cab.

.7 Provide polished metal handrails running along the full length of each cab non access wall. Return ends of handrails into face adjacent wall construction. Where possible use flat bar solid metal handrails in lieu of tubular handrail designs.

.8 On service elevators, include 300 mm high flat bar bumper railing, running along the full length of each cab non access wall. Railings shall be solid 6 mm thick stainless steel, and shall be fastened to cab platform as opposed to wall construction to prevent displacement of wall when hit.

.9 Provide stainless steel pad button hooks on each cab wall.

.10 Provide one set of protective pads, sized to suit cabin inside clearances and designed to cover all cab walls including entrance walls with cut outs for car panel and entrance door.

.11 Finished cab flooring shall be installed flush with the top of the car sill. Variance in elevation between the finished floor and the cab sill will not be accepted.

### 2.15 Remote Cab Licence Provision

.1 Apply to the T.S.S.A. for the remote location of in car license certificates. Include mention of this requirement within the Technical Standards and Safety Authority, Elevating and Amusement Devices Safety Division registration.

### 2.16 Wiring

1. Provide wiring to interconnect all elevator device including machine room, car, pit and hoistway. Use stranded conductors. Do not use solid copper conductors in any wiring connections.

2. Provide a minimum of 10% spares in all multiple conductor wiring runs.

3. Provide six pair of individually shielded #22 AWG conductors, plus 2 coaxial conductors in all travelling cables for Owner's future use. These are in addition to the required cabling for security card reader and CCTV camera provisions.

4. Shielded and coax wiring shall be run between controller in elevator machine room and
car control panel without breaks, splices or joined connections.

5. Terminate shielded and coax cable in elevator machine room within a junction box or terminal strip mounted in the controller.

6. Provide all wiring, conduit and troughing required within hoistway.

7. Provide wiring with insulated, moisture resistant, and flame retarding outer cover.

8. Provide flexible ETT traveling cables to connect car operating equipment and elevator machine room controller. Cables shall be provided with moisture resistant outer covers. Traveling cables shall be specifically designed for elevator use. Provide a minimum of 10% spare conductors in each cable.

9. Except for armoured flexible conduit, run wiring in metal duct and troughing. Provide troughing and duct with proper covers and end caps. Provide armoured flexible conduit as required.

2.17 Materials

1. Only new materials, components and devices shall be used in the fabrication, construction and installation of the elevator systems.

2. Stainless steel shall be type ASTM type 304, X-L Blend S or #4 satin brushed finish except where finishes are to be mirror polished where they shall be ASTM type 304 X-L buff finish.

3. Fasteners in fixture faceplates shall match the finish of their respective faceplates.

4. Non polished metal surfaces shall be constructed from pickled sheet steel. Steel shapes and members shall be free of defects.

2.18 Engraving and Signage

.1 All engraving shall be filled with black colored, permanent epoxy paint, except where such engraving is required by Code to be red.

.2 Use internationally recognized symbol to designate car-operating controls as much as possible. Where written instructions or designations must be used, provide instructions in English. Clearly show on shop drawings all instances where written instructions or designations are used.

2.19 Proprietary and Prototype Equipment

.1 Provision of proprietary equipment, limited or restricted access software and diagnostic tools, or equipment designed with automatic “time out” or “shut down” features will not be accepted.

.2 Provide University of Toronto with all diagnostic tools, equipment, software and manuals to allow others to undertake equipment maintenance other than the original installer.

.3 Under no circumstances shall prototype components or equipment be provided.
2.20 Annunciator Panel

.1 Provide at the Building EVAC station or within the CACF room an elevator annunciator panel containing remote fire emergency Phase 1 recall operation key switches (one per car or group of elevators), emergency power status lights (one per car or group of elevators), and two way voice communication to permit direct communication from annunciator panel to each and every elevator cab within the Building.

.2 Include all required interconnecting wiring running between elevator hoistway at grade level to annunciator panel.

3. EXECUTION

3.1 Installation

.1 Locate equipment machine rooms so they are conveniently located to their respective hoistways.

.2 Do not locate or position any non elevator or elevator related equipment within elevator machine room spaces.

.3 Elevator machine room access doors shall be provided with self locking and self closing hardware.

.4 Lighting levels inside elevator machine room spaces shall be a minimum of 200 lux, measured at the floor level with the access door closed.

.5 Elevator machine room spaces shall be provided with air conditioning suitably sized to accommodate the elevator equipment heat release rate.

.6 Elevator pit spaces to be provided with drains.

.7 Elevator pit drains to be designed to accommodate an outflow rate of 3,000 US gallons per hour, per elevator contained within the pit space.

.8 Elevator drain line leading to sump pit to be provided with back flow preventer.

.9 Ensure controller, disconnects and other electrical devices are positioned so that their access panels can be fully opened without making contact with room construction or adjacent devices or equipment.

.10 Provide suitable rail bracket fasteners and make secure attachments to hoistway construction.

.11 Set elevator entrance frames in proper alignment with car platform. Fasten frames to available wall and floor supports.

.12 Install hoistway fascia panels in vertical alignment with entrances, and running the full width of the hoistway. Provide stiffeners and additional brackets to prevent fascia panels, where provided, and hanger covers from warping.

.13 Exposed Work within car enclosure and hall landing entrances shall be fabricated in true
planes. Metal and wood sections shall be installed flat, be securely fastened and aligned to be straight and true. They shall be free of visible imperfections. Joints shall be accurately fitted, aligned and installed in same plane.

3.2 Wiring

.1 Install wiring in neat fashion.
.2 Tie wrap all conductors.
.3 Spare conductors shall be wrapped together and labelled with their ends insulated.
.4 Wiring connections shall be soldered or fastened to terminal strips or studs using approved mechanical fasteners.
.5 Provide wiring harness where multiplicity of conductors are terminated at remote panel terminal strips.
.6 Controller components shall be clearly marked with designations corresponding to those used on electrical circuit drawings.
.7 Provide insulated bushings around openings where travelling cable and other conductor cables are run through rigid structure or panels.
.8 Wiring connections to door detectors shall be protected from chaffing and splitting. Flexible power cord may be used between fixed car wiring and car door detectors as long as its cover is suitably protected.
.9 Run hoistway wiring within conduit or troughing.
.10 All car top and hoistway wiring shall be properly secured and neatly arranged using a minimum amount of flexible armoured conduit.
.11 Where armoured flexible conduit is used, provide conduit supports and fastenings at intervals of not more than 1500 mm (5 feet).
.12 Use proper anti shorts in all conduit connections.
.13 Terminate all spare wires and terminal strip mounted within controller, or neatly secure and bundle up loose conductors into one neat coil.

3.3 Touch Up and Cleaning

.1 Comply with requirements as set out in Division 1.
.2 Remove from all polished metal surfaces, protective wrapping. When the failure to properly remove protective wrapping from moving parts causes scratches or other blemishes in polished metal work visible to the public, the elevator installer shall be responsible to remove damaged cladding and provide new replacement cladding at no additional cost to U of T.

3.4 Painting

1. Comply with requirements of Division 1.
2. Pit equipment, except for machined metal surfaces (i.e. running surfaces of guide rails...
and buffer pistons) shall be painted in gloss black enamel.

3. Prime coat painted surfaces shall be finished in manufacturer's standard enamel finish.

4. Factory applied finish paint shall be touched up where damaged. Do not paint over equipment data tags or nameplates.

5. Apply mechanically reproduced car number designation to controller, drive motor and brake housing after finish coat painting.

3.6 Demonstration and Training

1. Provide for one full day, one technically competent technician or crew, conversant with the equipment as installed, to demonstrate system performance and operation to U of T designated staff. Training shall include system troubleshooting and fault look up procedures, fault log clearing procedures, means of safe machine room inspection operation, means to adjust set operating parameters, copying and replacing EEPROM codes, means of adjusting motor acceleration and deceleration rates, means of adjusting car levelling, and other aspects of equipment performance as required for a person expected to service or maintain this equipment. Furnish and provide all tools and training materials as required for this session.

2. Provide for an additional half day, one technically competent technician or crew, conversant with the equipment as installed, to demonstrate elevator remote controls and monitoring system, as well as life safety operations.
April, 2015

Introduction

The following are the University of Toronto Mechanical Design Standards. The information contained within these standards must be followed unless:

1. They cannot be applied to the specific design work planned. The design consultant must present the information to the Project Manager to point out the problem and receive permission to implement the alternative solution.

2. If an alternate product or system is available, which is the recommended standard of the consultant for the project, approval may be requested for such an alternate through the Project Manager.

3. If there is a conflict between the standards and codes, such issues should be brought to the attention of the Project Manager for a decision on what to use.

4. If there is a substantial cost savings to be realized by changing from a particular standard and the consultant is recommending such a saving, the Project Manager will consider such a request. The consultant might be requested to substantiate the cost savings.

5. The consultant must point out any problems with the standards, and provide alternates that may be more appropriate. The consultant is also encouraged to comment on the appropriateness of the standards as compared to general industry standards.

6. Should there be a discrepancy between products or models stated in the text of this standard or in Appendix A – “List of Mandatory and Preferred Manufacturers”, Appendix A shall have priority.

7. The Project Manager must consult with the appropriate operating division of Facilities and Services before giving approval for any deviations from this Standard.
# MECHANICAL DIVISION 15 PART 2 SECTION B

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**Note:**
- For Fire Alarm requirements refer to Division #28 31 00.
- For Fire protection sprinklers, piping and pumping requirements, refer to Section Division #21 xx xx
- For Controls/BAS requirements, refer to Division 25 xx xx
Appendices

A) List of Preferred and Mandatory Manufacturers       p. 29-30 
B) Diagram 15.1: Chilled Water Coil Moisture Evacuation p. 31 
C) Diagram 15.2: Control Air Filtration Station p.32 
D) Diagram 15.3: Sample Condensate meter installation p.33 

Basic Mechanical Design Guidelines

1. All work on pressure vessels, boilers and power piping shall only be done by companies that are registered and certified by the Technical Standards and Safety Authority (TSSA) of Ontario.

2. Due to the capacity and hydraulics limitations of the Mechanical utilities from the Central Heating Plant (17 Russell Street) and the Central Cooling Plants (North-West Chiller, Bahen Centre and Medical Sciences), verify the addition of new loads onto these systems with the Director, Utilities and Building Operations.

3. Metering: (also refer to metering requirements within section 25 xx xx)
   • Provide monitored (connected to building DDC system) flow, temperature and energy meters on all central cooling water, steam and high temperature water.
   • Provide volume metering on all irrigation system supplies, cooling tower city water makeups and bleeds and swimming pool makeup. Provide shutoff valves and a bypass connection as necessary to allow continuous service when maintenance is performed on the meters.
   • As it is often the case that construction activities will require the use of University-generated heating or cooling energy prior to the University’s takeover of the new facilities, the above metering must be fully installed, operational and commissioned prior to the University allowing the opening of any shutoff valves for the heating or cooling systems.

4. Lifts or removable ladders shall not be relied upon for access unless approved by University representative.

5. Provide pedestrian waterproof traffic topping system over entire mechanical room floor including over housekeeping pads under air handling units etc (see architectural finishes section).

6. Consultant shall include a statement in the specifications to the effect that all components of the mechanical systems (e.g. fans, ducting, insulation, sound attenuators, air terminal boxes, pumps, VFD drives etc) must be kept clean and dry as manufactured, delivered, stored and installed before operating the mechanical systems.

7. The abandonment of existing equipment and material in place is not acceptable. Abandoned systems can become a serious liability since it cannot be easily determined what is active and what is not. The correction of existing mechanical problems and removal of abandoned mechanical equipment while maintaining the proper operation of the building, all need to be addressed in the contract documents.

8. These standards are intended to be cost effective standards. The consultant, however, should understand that the University strives to achieve sustainability, operability, more permanence and lower long term maintenance costs incurred in the products that are purchased and installed. The standard therefore, might be slightly higher than the normal commercial standard.
Mechanical Design Standards - Checklist

The Design Team is required to read and comply with the full Design standard as it applies to this project. A completed copy of this checklist must be submitted by the Design Team to the University's Project Manager at the end of the Design Development Phase. In all cases, if a “does not comply” has been noted, please indicate why. Attach additional sheets as necessary.

15 xxx MECHANICAL

15000 Placement of Equipment

1. General:
   1.1. Do not locate equipment in areas which are difficult to access and maintain. ☐ ☐ ☐
   1.2. Do not locate equipment in window wells, etc. that are at risk of flooding. ☐ ☐ ☐
   1.3. Provision must be made for lifting and moving spare supplies, parts, equipment and chemicals into and out of mechanical rooms. Consider providing electric hoist or elevator. ☐ ☐ ☐
   1.4. The location of fresh air intake for buildings is extremely important. They must be located so that no car, truck or diesel generator fumes get drawn into the air system. The designer must consider the location in relationship to parking, shipping and receiving areas, loading docks etc. ☐ ☐ ☐
   1.5. Avoid locating air vents on grade. If this is absolutely necessary, then the grates must be fastened down securely, and protection from outside influence must be provided. ☐ ☐ ☐
   1.6. Provide adequately sized access pathways for the repair, maintenance and eventual replacement of the equipment such as heating/cooling coils and other large pieces of equipment. ☐ ☐ ☐

2. Mechanical room floors:
   2.1. Provide sealed curbing of all floor penetrations. Curbing shall be at least 6" high. (Coordination with Architect required) ☐ ☐ ☐
   2.2. Provide adequate floor drains, and slope floors down to the drains. Provide individual floor drains for equipment discharge. ☐ ☐ ☐
   2.3. Provide pedestrian waterproof traffic topping system over entire mechanical room floor including over housekeeping pads under air handling units etc (see architectural finishes section). ☐ ☐ ☐

3. Placement of equipment on roof:
   3.1. Air handling units with chilled water and hydronic coils shall utilize an appropriate glycol solution or be drainable and fitted with coil moisture evacuation fittings (see sketch # 15.1 in appendix B at end of these standards). The use of and location of steam coils in air handling units shall be approved by U. of T. representative. ☐ ☐ ☐
   3.2. Cooling towers shall be equipped with platforms constructed in such a way as to allow easy and safe access to serviceable components (e.g., motors, fans, valves etc). (Coordination required between Mechanical consultant & Architectural consultant for walkways and roof accessories). ☐ ☐ ☐
   3.3. Access to the roof for mechanical room access shall be by normal stairs and doors rather than ladders and hatches. Lifts or removable ladders shall not be relied upon for access unless approved by University representative. (Coordination required with Architect). ☐ ☐ ☐
3.4. Adequate rooftop walkways must be provided for servicing mechanical equipment. These walkways shall be raised at least 4” above roof grade, shall be minimum 30 Inch width, be equipped with handrails and shall run from roof access to the maintenance areas of the equipment on roof. These walkways shall be constructed of galvanized steel grating or wood boards. (Refer to Architect for roof platforms, walkways & roof accessories).

3.5. The roof is to be protected from damage during equipment installation.

3.6. All guy wires shall be adequately identified with yellow protective sleeves.

3.7. If possible equipment should not be placed closer than 6’ 0” from the edge of the roof. Any mechanical equipment, (such as fans, AC units, etc.) that must be located within 6 ft. or less of roof perimeter, shall be provided with guard-rails unless there is a parapet wall of 36” high minimum at the roof perimeter. (Refer to Architect for roofing design & accessories).

3.8. **Fundamental Instructions for Installation of New Equipment on Flat Roofs**

3.8.1. Any new equipment that is to be installed on a **steel framing** (for example but not limited to; cooling towers, faculty equipment etc) above the roof level shall maintain a 30” clearance between the top of the roof system and the bottom of the equipment). This space is required to ensure access to the roof membrane under the equipment. The supporting I-beams must clear the top of the roof by minimum 12”, and there must also be access to the space under the equipment. (Refer to Architect, roofing consultant and structural engineer).

3.8.2. Any new equipment that is to be installed on top of a **curb/base/sleeper** (for example but not limited to; Exhaust fans, packaged roof top AC units, air cooled condensers, rooftop installed air-handling units) shall be mounted to ensure a clearance of 12” to 18” from the top of the roof level. (Refer to Architect & roofing consultant)

3.8.3. Ducting, piping and conduits (for example but not limited to; Cooling tower condensate water piping, side/end discharge of air-handling unit’s duct work running above the roof, refrigeration piping, electrical/control wiring, gas lines etc) shall be installed a minimum 12” above top of roof level. If the piping or duct work bundled together or the duct is wider than 24”, then the clearance from the top of the roof level must be increased from minimum of 12” to ensure access to roof membrane. (Refer to Architectural & roofing consultant).

3.8.4. To ensure the integrity of the new roofing, all roof penetrations must comply with IRC’s detailed construction. Pitch pocket type of roof penetration are not to be used. (Refer to Architect & roofing consultant).

3.8.5. Existing equipment on old roofs, which will be replaced with the new roofing system, shall be lifted (relocated) during the re-roofing process to the heights outlined above to ensure proper access to roof membrane for maintenance purposes. (Refer to Architect & roofing consultant).

3.8.6. Paint gas lines in their entirety where exposed to the outdoors.

**15060 Pipe Supports and Hangers**

1. Provide sufficient supports and hangers for pipe services per code. Heated plastic pipes shall have continuous pipe trays on horizontal runs.
15075 Identification of Piping Systems:

1. All piping except where actually concealed in a pipe space or chase shall be identified according to latest ASME A13.1 "Scheme for the Identification of Piping Systems". Directional arrows indicating the direction of flow shall be applied adjacent to each identifying legend location. The code consists of two colours for primary (background) and secondary (wording and abbreviations identifying the fluids or gases being carried within the piping) classification.

15080 Mechanical Insulation

2. 30 gauge aluminum cladding protection shall be used for protection in high traffic areas and where exposed to ultraviolet light and weather (e.g. roofs, etc). Use of PVC Zeston 2000 by Johns Manville would be acceptable elsewhere.
3. Use of PVC cladding is acceptable on cold water, chilled water, heating water and steam piping and fittings. Where a vapour barrier is required, the barrier shall be an integral part of the insulation.
4. Provide removable/replaceable insulation sections at control valves, metering stations, orifice plates.
5. Provide insulation on cold water drains where required.

15100, 15200, 15300 Pipes & Fittings

(Note: For Fire Protection Piping requirements, see separate Div. 13)

1. Provide galvanized schedule 40 pipe sleeves for all piping penetrations through concrete and masonry. (Coordinate with architectural and structural for location and installation).
2. Safety relief devices shall be vented individually, and connected vent piping shall be designed to convey the fluid, without pockets, to the outside atmosphere, and then directed away from equipment ventilation systems and vents from other systems.

Pipe and pipe fittings shall be in accordance with the following schedules:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Hot &amp; Cold: (above ground)</td>
<td>Copper Type L</td>
<td>Wrought Copper</td>
<td>Soldered, Propress, Victaulic Grooved end</td>
</tr>
<tr>
<td>Domestic Cold Water: (buried)</td>
<td>Copper Type K, Ductile Iron (Under 2&quot;)</td>
<td>Wrought Copper, Ductile Iron</td>
<td>Soldered Joint, Mechanical Joint</td>
</tr>
</tbody>
</table>

(C = Complies  NC = Does Not Comply  NA = Not Applicable)
# Storm and Sanitary Sewage

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm: RWL (vertical runs only inside building)</td>
<td>Cast Iron</td>
<td>Cast Iron</td>
<td>Mechanical Joint,</td>
</tr>
<tr>
<td>Storm: (buried outside building)</td>
<td>Cast Iron PVC Sch80 Concrete</td>
<td>Cast Iron PVC</td>
<td>Mechanical Joint PVC Solvent</td>
</tr>
<tr>
<td>Sanitary: (up to and including 3&quot;)</td>
<td>Copper Type L PVC in Fire Separations</td>
<td>Wrought Copper</td>
<td>Soldered Joint</td>
</tr>
<tr>
<td>Sanitary: (over 3&quot; inside building)</td>
<td>Cast Iron</td>
<td>Cast Iron</td>
<td>Mechanical Joint</td>
</tr>
<tr>
<td>Sanitary: (buried)</td>
<td>Cast Iron PVC Sch 80</td>
<td>Cast Iron PVC</td>
<td>Mechanical Joint PVC Solvent</td>
</tr>
</tbody>
</table>

# Steam /High Temp Hot Water (HTHW) and Condensate

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam/HTHW (1-1/4&quot; and under)</td>
<td>Seamless Sch80</td>
<td>Sch80</td>
<td>Socket welded up to 1st isolating valve threaded after</td>
</tr>
<tr>
<td>Steam/HTHW (1-1/2&quot; and over)</td>
<td>Seamless Sch40</td>
<td>Welded Fitting</td>
<td>Welded (10% X-rayed)</td>
</tr>
<tr>
<td>Condensate (1-1/2&quot; and under)</td>
<td>Seamless Sch80</td>
<td>Sch80</td>
<td>Threaded</td>
</tr>
<tr>
<td>Condensate (over 1-1/2&quot;)</td>
<td>Seamless Sch80</td>
<td>Welded Fitting</td>
<td>Welded</td>
</tr>
</tbody>
</table>

1. All valves connected to the U of T district heating system (steam or HTHW) must be welded and have CRN numbers.

2. 
   a) Steam drip trap valves to be ¾" WO4-2054T-02TS Velan Bellows sealed valves or equivalent. All piping, valves, fittings and flex hose materials must comply with CSA B51 and ASME B31.1 power piping code and must have CRN numbers. Pressure relief valves must be reinspected and have revalidated CRN #
   
   b) High pressure steam drip traps shall be of Bestobel manufacture, bimetallic type, Model DM-25.

3. All piping joints must be hydrostatic / pneumatic tested as per applicable ASME 331.1 Section code or 100% x-rayed if above test is unsafe.
### 4. Air Conditioning Heating and Cooling Medium

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Water, Chilled Water &amp; Glycol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Within building or tunnel</td>
<td>1-1/2” and under: Sch40</td>
<td>1-1/2” and under: Sch40</td>
<td>1-1/2” and under: Sch40</td>
</tr>
<tr>
<td></td>
<td>2” and over: Sch40</td>
<td>2” and over: Welded or Victaulic type.</td>
<td>2” and over: Welded or grooved end, e.g. Victaulic</td>
</tr>
<tr>
<td>Heating Water - buried</td>
<td>Ricwil pre-insulated or approved equivalent</td>
<td>Ricwil or approved equivalent</td>
<td>Ricwil or approved equivalent</td>
</tr>
<tr>
<td>Chilled water - inside building or tunnel</td>
<td>Sch40</td>
<td>1-1/2” and under: Threaded 2” and over: Victaulic or welded</td>
<td>Welded or Victaulic Grooved end</td>
</tr>
<tr>
<td>Chilled water - buried</td>
<td>Ricwil pre-insulated pipe or approved equivalent</td>
<td>Ricwil approved</td>
<td>Ricwil approved</td>
</tr>
</tbody>
</table>

1. Filament-wound fibreglass epoxy type is NOT an acceptable option
2. Ricwil buried piping shall incorporate a leak detection system. Piping shall incorporate Galva-Gard hot dipped galvanized outer casing.

### 5. Air

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed air – shop</td>
<td>Stainless Sch 5 or 10</td>
<td>Stainless Steel</td>
<td>Screwed or grooved end, (e.g. Victaulic)</td>
</tr>
<tr>
<td>Compressed air - lab control air</td>
<td>Copper Type L stainless steel SS-304</td>
<td>Copper SS-304</td>
<td>Joint Welded; under 2” Pressfit (e.g. Propress); Joints 2” or over; welded or grooved end (e.g. Victaulic)</td>
</tr>
<tr>
<td>Vacuum Line</td>
<td>Copper Type L Sch40</td>
<td>Copper/ Mall Iron</td>
<td>Soldered Joint/ Screwed</td>
</tr>
</tbody>
</table>
6. Gases, Chemicals and Laboratory Services

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled water</td>
<td>PVC</td>
<td>PVC</td>
<td>PVC Solvent</td>
</tr>
<tr>
<td>Deionized water</td>
<td>PVC</td>
<td>PVC</td>
<td>PVC Solvent</td>
</tr>
<tr>
<td>Reverse osmosis water</td>
<td>PVC Sch80</td>
<td>PVC</td>
<td>PVC Solvent</td>
</tr>
<tr>
<td>Natural gas, 2&quot; and under</td>
<td>Sch40</td>
<td>Mall Iron</td>
<td>Screwed Viega Propress</td>
</tr>
<tr>
<td>Natural gas over 2&quot;</td>
<td>Sch40</td>
<td>Welded Fitting</td>
<td>Welded</td>
</tr>
<tr>
<td>Laboratory waste - above ground</td>
<td>Glass or as necessary for the service</td>
<td>Glass or as necessary for the service</td>
<td>Coupling Joint</td>
</tr>
<tr>
<td>Laboratory waste - buried</td>
<td>CPVC Sch80</td>
<td>CPVC</td>
<td>CPVC Solvent</td>
</tr>
</tbody>
</table>

7. Other Services

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PIPE MATERIAL</th>
<th>FITTINGS</th>
<th>JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawn Sprinkler</td>
<td>PVC</td>
<td>PVC</td>
<td>PVC Solvent</td>
</tr>
</tbody>
</table>

15100, 15780, 15935 Heat Transfer

1. Provide reverse return hydronic piping systems.
2. Individual (ie, separate loop from those serving A/H Units) hydronic circulating loop shall be provided for radiant panel heat transfer systems in order to maintain performance of radiant panels. Do not use radiant panel heating for reheat purposes.
3. Constant 180 degree Fahrenheit supply water shall be used to serve radiant panels.
4. Individual hydronic circulating loops shall be designed for different systems to maintain control integrity, i.e., greenhouse heating system should not be coupled to general building heating.
5. Glycol heating or cooling:
   Use 50% (by volume) solution of propylene glycol and water for heating systems and 20% (by volume) solution for cooling/air conditioning systems. Use of a preheat coil for fresh air intake using hot glycol shall be discussed with U of T representative.
6. Heat recovery systems which incorporate the transfer of energy between exhaust air and fresh air are preferred wherever possible.

15110 Valves

1. Isolating valves.
   1.1 Acceptable manufacturers in this section include: Challenger, Zurick, and Apollo.
1.2 Provide isolating valves for all plumbing fixtures and appliances.

1.3 Provide isolating valves on both inlet and outlet sides of all mechanical equipment to allow easy service. Equipment in this category shall include but not be limited to coils, pumps, pressure reducing valves, control valves, and balancing valves.

1.4 Provide isolating valves on hot, cold and recirculating water services to all washrooms and labs.

1.5 Balancing valves shall not be used as isolating valves.

1.6 Isolating valves for various services shall conform to the following table:

<table>
<thead>
<tr>
<th>Service</th>
<th>Ball</th>
<th>Gate</th>
<th>Butterfly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dom. hot water</td>
<td>≤ 2”</td>
<td>&gt; 2”</td>
<td>&gt; 3”</td>
</tr>
<tr>
<td>Dom. cold Water</td>
<td>≤ 2”</td>
<td>&gt; 2”</td>
<td>&gt; 3”</td>
</tr>
<tr>
<td>Steam &lt; 15 psig</td>
<td>≤ 1.5”</td>
<td>&gt; 1.5”</td>
<td>No</td>
</tr>
<tr>
<td>Steam &gt; 15 psig</td>
<td>≤ 1”</td>
<td>&gt; 1”</td>
<td>No</td>
</tr>
<tr>
<td>High temperature hot water</td>
<td>≤ 1”</td>
<td>&gt; 1”</td>
<td>No</td>
</tr>
<tr>
<td>Secondary heating water</td>
<td>≤ 2”</td>
<td>&gt; 2”</td>
<td>&gt; 3”</td>
</tr>
<tr>
<td>Cooling tower water</td>
<td></td>
<td>See 1.8</td>
<td></td>
</tr>
<tr>
<td>Chilled water</td>
<td>≤ 2”</td>
<td>&gt; 2”</td>
<td>&gt; 3”</td>
</tr>
<tr>
<td>Distilled, de-ionized, reverse osmosis water</td>
<td>See 1.6</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

1.7 Isolating valves for distilled, de-ionized and reverse osmosis water shall be PVC ball valves. Ensure that the material is compatible with the fluid.

1.8 Butterfly valves used in cooling tower systems shall have seats and seals capable of resisting attack from the water treatment chemicals.

1.9 Connections and valve ratings shall be compatible with pressure and temperature conditions.

1.10 Sectional valves shall be used where possible in piping systems for ease of repairs.

1.11 Self-actuated (Braukman) valves may be used on hot water and steam radiator systems.

2. Buried valves
   2.1 All buried valves shall close in a clockwise direction.
   2.2 Provide curb box for all buried valves for lateral services and valve chamber for valves on water mains; size and construction of curb box and valve chamber shall comply with latest City of Toronto standard.

3. Emergency Diesel Generator Set
   3.1 A fusible fire shutoff valve shall be installed in the fuel supply line.

4. Balancing valves
   4.1 Balancing valves 2” or less shall be globe type.
15140 Back Flow Preventers
1. Main incoming domestic water from the street requires a duplex arrangement c/w isolating valves. Provide backflow preventers in locations and configuration per applicable codes. Acceptable manufacturer shall be Watts.

2. Laboratory facilities shall have backflow prevention provided to conform to CSA Standard B64.10 or latest version.

15150 Plumbing Traps
1. Plastic Poly pipe is acceptable for under-slab trap seal primer lines. Exposed shall be copper Type K soft tubing.

2. Running traps shall have cleanouts on both legs.

15150 Cleanouts and Cleanout Covers
1. Drain cleanout locations shall comply with plumbing code. These should also be installed through the floor of the room for which they serve, wherever code allows. Covers shall be of square shape.

15160 Drainage
1. For outside drainage (storm water management), brass drain catch basins sometimes prove to be too narrow to handle any sudden flow rates. Ensure drain size is adequate.

15180 Piping Expansion Joints
1. Bellows joints shall not be used unless the consultant can demonstrate that there is no other reasonable choice. Provide appropriate offsets in piping or expansion loops instead to accommodate thermal expansion.

15180 Centrifugal Pumps
1. Provide 100% back up for circulating pumps of heating, cooling and condenser water systems as well as city water boosters. In-line centrifugal pumps are preferred.

2. All exposed moving parts of pumps shall be properly guarded.

3. Mechanical seals are preferred rather than stuffing box style.

4. Provide gauge ports across pumps. A single gauge shall be piped and valved to allow isolation of pump suction and discharge pressures gauges

5. Provide a duplex system of fine mesh filters/strainers upstream of the pumps, complete with isolating valves, both before and after the filters/strainers.

6. Provide individual supports for centrifugal pumps and vibration isolators between pumps and pipework as appropriate.

7. Use variable frequency drive or variable speed pump for City booster pumps over 2HP. Include pressure sensor located at top floor for control of pressure.

8. Bleed line complete with solenoid shall be provided to protect the pump from overheating.
15180 Steam Components

1. Steam Traps:
   1.1. High pressure steam (above 50 PSig) system shall have thermostatic traps selected for continuous system operation at a specific design temperature. Bimetallic traps (Bestobell DM-25) shall be used for high pressure drip traps. 
   1.2. Low pressure steam systems up to 15 psig shall have float and thermostatic traps of Spirax-Sarco manufacture. Rad traps shall be either of Spirax-Sarco or Dunham-Bush manufacture.

2. Pressure Reducing Valves:
   2.1. Building main pressure reducing valves shall be Masoneilan series 500 or Fisher model 655 or 92B or C pilot operated and self-actuating.
   2.2. Shall be dual-station type if pressure difference exceeds 100 psig.

3. Provide strainers on the inlet side of steam traps and control valves to prevent dirt and pipe scale from entering the devices.

4. New buildings supplied with steam shall have Spirax Sarco Gilflo variable orifice steam metering shall be connected to the building BAS. (See Section 15900 Energy & Flow Metering for particulars).

5. All steam coils shall include a steam vacuum breaker

6. High pressure steam valves shall be industrial grade, suitable for working pressure and temperature requirements. Bellows non-leak or zero-leak type operators are preferred.

15210 Laboratory Natural Gas Shutoff Valves

1. Provide emergency shut-off valve in a cabinet with glazed door and proper signage at the entry to each laboratory. Provide downstream of this shut-off valve a check valve with soft disk.

15220 Reverse Osmosis (R.O.) Water Service

1. Provide booster pump(s) on feed supply to R.O. unit(s) to maintain residual pressure at 35 psig.

2. Provide duplex treatment system if continuous flow is essential.

3. All systems shall be supplied with city water makeup meter as well as RO output meter.

15410 Plumbing Fixtures and Trim

1. Plumbing fixtures shall be white colour except where otherwise specified.

2. Lavatory faucets shall be fitted with replaceable cartridges, not washers.

3. Lavatory basin wastes shall have grids and extra heavy quality traps.

4. Water closets shall be siphon jet type.

5. Do not use chain and plug for basins. Provide grids at drain outlet instead of pop-up drain.

6. ‘Cheater vents’ are not to be used on any system.

7. All urinals shall have cleanouts located above flood level of fixture as per plumbing code.

8. All banks of toilets (three or more, shall have four inch cleanout located in the same room as the fixtures as per plumbing code.

9. All outside hose bibs shall be frost free.
10. Floor drains shall be located in all washrooms and in any lab with a deluge shower.  

11. Use of hands-free faucets, urinals and toilets is preferred and shall be discussed with UofT representative. All fixtures shall be low flow water saving type. See appendix “A” at end of these standards for schedule of acceptable manufacture/models of fixtures etc.

15410 Vanity Basins
1. The provision of lavatory basins mounted in vanity units is preferred for ALL washrooms.

2. For plumbing fixtures for physically challenged people, refer to Accessibility Standards.

15410 Mop Sinks (Also refer to “Cleaning & Caretaking Standards”)
1. Minimum one (1) mop sink per floor is required.

2. Mop sinks shall be floor mounted (with a 6” lip above floor level).

15412 Emergency Eyewash & Safety Shower Units
1. Units shall comply with U of T Environmental Health & Safety specifications which can be found at the following link under item “Emergency Eyewash and Shower Standard”: Policies and Procedures Listing

15426 Drinking Fountains
1. Drinking fountains shall be ‘EZH2O’ combination fountain/bottle filling station manufactured by ELKAY commercial products. They shall be OADA compliant for wheel chair access, have tamperproof fasteners and all-stainless steel surfaces. The water supply shall incorporate a separate one-quarter turn shutoff to enable filter replacement.

2. Preferred location requirements as follows: lecture halls, classrooms, large student labs/computer rooms, lobby areas, gymnasiums and cafeterias. The units should be installed in a central area and easily accessible to everyone.

15440 Sump Pumps
1. Sump pumps shall be Gorman Rupp or Gould Pumps manufacture or equivalent and shall be self-priming surface mounted direct drive type with the exception that fractional horsepower units may be of the submersible type.

2. ‘Column’ style pumps are not acceptable.

3. Shall be fully serviceable.

4. Shall be connected to emergency power.

15470 Pipeline Filters Installation
1. If pipeline filters are present for equipment serving laboratories, provide shut off valves upstream and downstream of the filters.

15480 City Water for Air Conditioning
1. Air conditioning equipment that uses once-through city water for cooling shall not be used.
15545 Water Treatment Standard

PART I – GENERAL

1.1 GENERAL REQUIREMENTS

1.1.1. The water treatment vendor to be used on building additions and new construction shall be the incumbent supplier used by the campus for the rest of its buildings.

1.1.2. Conform to the conditions stated in the University’s water treatment contract from the detailing of the automation systems and associated software, to the outline of specific products required for pre-cleaning and inhibition programs.

1.2 WORK INCLUDED

1.2.1. Furnish all consulting, shop drawings, materials, instruments and program instruction necessary for all required aspects of the water treatment program, including testing of said program.

1.2.2. Clean and re-inhibit ALL new and existing recirculating closed systems such as Chilled Water, Glycol and Heating Water Systems, as well as any open systems such as the Condenser Water Loop. Supply ALL necessary chemicals to perform the above. NO cleaning activity shall adversely affect the existing systems by contaminating them with foreign deposits from new piping cleaning process. Cleanings must be performed independent of each other.

1.3 QUALITY ASSURANCE

1.3.1. Provide proof of ISO-9001 accreditation.

1.3.2. Provide the services of the incumbent water treatment supplier currently employed by the University to service the campus buildings to supervise system pre-cleanings and inhibition programs and to certify that the work has been successfully completed, via reports from their laboratory analysis. All chemicals used for cleaning treatment must be compliant with outlined products in each application of this specification.

1.3.3. The flushing, cleaning and chemical treatment programs shall be administered by the Water Treatment Consultant who shall supply installation drawings, on-site supervision, detailed description procedures, and written instruction of the chemical treatment dosages control charts and test procedures. The Water Treatment Consultant must also provide automation and software program outline and training to on-site staff.

1.3.4. Test procedures shall be in accordance with applicable portions of ASME, ASHRAE, SMACNA, NFPA, CFA, ANSI and other recognized test codes as far as field conditions permit. Spectrophotometry technology must be used in on-site testing methods for all aspects of treatment program to ensure accuracy of results.

1.3.5. Maintain treatment program in such a manner as to ensure that fouling factor does not exceed 1 degree C rise above the normal operating temperature difference between condenser water leaving temperature and liquid refrigerant leaving temperatures. Program must ensure heating and cooling systems are kept deposit-free by achieving the following corrosion rate criteria:

<table>
<thead>
<tr>
<th>Mild Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Systems</td>
<td>&lt; 0.5 mm/year</td>
</tr>
<tr>
<td>Closed Systems</td>
<td>&lt; 0.05 mm/year</td>
</tr>
</tbody>
</table>
PART II - PRODUCTS

2.1 PRE-OPERATIONAL CLEANER

2.1.1 Cleaner must ensure the REMOVAL OF ALL organic deposits such as pipe dope, oil and grease deposits. Surface corrosion must be removed by DISSOLVING rust at a NEUTRAL pH, while preventing flash rusting, utilizing same said cleaner. No TSP (Tri-Sodium Phosphate) is to be used due to its environmental impact. The Water Treatment Consultant must provide proof of cleanser's properties via product fact sheet and MSDS. Quantity of cleaner required in association with system volumes must also be submitted.

2.1.2 Cleaner must have long-term metallurgical passivating properties to ensure piping integrity through zone tie-in during the cleaning stage. Passivator must have potential in cleaner to last 2-6 months if required. Again, evidence is required via product fact sheet and MSDS.

2.2 CLOSED SYSTEM TREATMENTS & EQUIPMENT

2.2.1 Closed System inhibitor must be of the sodium molybdate type with non-sodium hydroxide pH buffers within. Proof is required via product fact sheet and MSDS. Dosage control parameters to maintain 80-100 ppm as molybdenum, in system at all times through completion of cleanings to turn over to owner and plant staff.

2.2.2 Chemical bypass feeder: Feeder shall be complete with isolating valves, drain valve, and funnel feeder with isolating valve. One unit for each system. Bypass feeder to act as back up to automation system in place, monitoring closed loops.

2.2.3 In-line filters: Filter housing sized to handle 5 percent of recirculating rate of system. The filter shall be of steel construction and shall be capable of operating at the system working pressure.

2.2.4 Each closed system shall have a minimum ¾ inch Cold Water Contact Head makeup Meter which will tie into the PLC Controller (if applicable), providing control of closed system treatment levels for water treatment automation.

2.3 COOLING TOWER TREATMENTS & EQUIPMENT

2.3.1 Chemicals: No Organo Phosphate (primary ingredient) or Chromate based scale and corrosion inhibitors shall be used in the open loop. The mode of corrosion and scale protection shall be an ALL ORGANIC natured program that is halogen resistant and environmentally friendly.

2.3.2 An oxidizing biocide shall be used in conjunction with a non-oxidizing biocide to ensure the most effective biological kill efficiency with the least environmental impact. Said biocides are also known components of killing the legionella bacterium.

2.3.3 Chemical bypass feeder: Feeder shall be complete with isolating valves, drain valve, and funnel feeder with isolating valve. This shall act as a back up to the feed automation system.

2.3.4 CHEMICAL FEED EQUIPMENT: Contact head cold water meters for makeup and bleed off shall be provided and tied in to the PLC based automation control panel. The Water Treatment Data Software Program shall be modem, remote viewing friendly.

2.3.5 Signals of control must come from Micrologics Control System (PLC based) with data being transferred to Water Treatment Data Software Program must be in Windows application, and able to store data transferred from PLC and/or manual data entry. Software program installment is required and training of software to on-site staff must be performed.

2.3.6 The control system shall feed organic inhibitor based on a software program that allows for a contact to come from the makeup water meter, base bleed off or conductivity regulation, and incorporate a dual biocide feed program, all coming from the PLC based controller.

2.3.7 Chemical pumps shall be provided for the organic inhibitor and the two biocides. Utilize compatible Pulsatron chemical feed pumps. Feed signal from the control device and suitable
for the application. Three Pulsatron pumps required.

2.3.8. Sequence of Operations: A Jesco water meter on the makeup line to the cooling tower will send signals to the programmable controller. The controller registers the volume (litres/gallons) of water passing through the flow meter and causes the organic inhibitor feed pump to activate proportionately. Chemicals are all fed directly from on-site stations with level control sensors in the containers (use flexible hoses for pumps). The control system will regulate bleed off by measuring the conductivity of the cooling water and provide a visual display of real time conductivity, pH and ORP for oxidizing biocide feeding at all times. When the conductivity of the water exceeds a programmed set point, a bleed solenoid is activated. The biocide will be controlled by an ORP controller (or optional “Actives-based” online colourimetric analyzer) so that a free available halogen residual of 0.3 to 0.5 ppm FAC is maintained on the condenser side. The discharge of the chemical feed pumps shall be piped downstream of the bleed off solenoid, to the supply line to the Cooling Tower.

2.3.9. Bleed off solenoid must be suitable for 1-inch bleed off line with isolation BALL valves to enable isolation of solenoid in case of repair.

2.3.10. Corrosion coupon racks to be provided for each closed and open loops. Each rack must consist of 4 coupon locations installed across a recirculation pump or headers that allow for constant flow past the coupons installed. Each rack must have isolation ball valves with a drain line and flow regulators. Shall provide corrosion monitoring coupons along with laboratory results for 1 year after turnover of plant to the owner.

PART III - EXECUTION

3.1 CLEANING AND FLUSHING

3.1.1. Thoroughly inspect all piping systems and remove heavy debris and excessive oil, grease, pipe dope and surface corrosion.

3.1.2. Install temporary strainers, grids and filters just prior to cleaning and flushing piping systems.

3.1.3. Flush and clean systems before opening new piping system to existing system. Certify that systems are clean and inform consultant when system cleaning is complete. Demonstrate to consultant that systems are cleaned. Once approved, open new system to existing systems.

3.1.4. During flushing and cleaning, maintain all isolating and control valves in the open position. Also allow for Zone tie-ins.

3.1.5. Provide a letter of certificate when all cleaning and flushing has been carried out in accordance with the specifications, and authorities having jurisdiction (City of Toronto, Ministry of Environment etc.). Include copies of certificate in the Program Operating Manuals.

3.1.6. CLOSED SYSTEMS

3.1.6.1. Provide temporary caps, connection points, etc. as required to subdivide large systems to ensure a thorough cleaning. Install temporary connection between supply and return lines to permit circulation.

3.1.6.2. Circulate pre-operation cleaner for a minimum of 72 hours. Periodically clean all strainers and repeat flushing operating to the approval of the consultant until no foreign material collects in the strainer.

3.1.6.3. Drain and purge system and clean all strainers. Refill with fresh water and circulate to flush out remaining chemical solution, via fill and flush process.

3.1.6.4. Drain system and remove temporary caps, circulation connections, etc. for permanent operation. Refill using clean water and immediately treat with the corrosion inhibitor.
required for permanent operation.

3.2 CHEMICAL TREATMENT

3.2.1. CLOSED SYSTEMS

3.2.1.1 Provide chemical treatment equipment, chemicals, and test equipment for heating, chilled, and glycol closed water systems.

3.2.1.2 Supply and install on each pumping system a bypass feeder and in-line filter.

3.2.1.3 Provide sufficient corrosion inhibitor chemical in each system to raise initial molybdenum level to 80 ppm. Provide additional 114 litres (25 IG) of corrosion inhibitor chemical for each system.

3.2.2. COOLING TOWER WATER SYSTEMS

3.2.2.1 Provide a complete system of water treatment for the cooling tower to control scale, corrosion and algae/bacteria growth complete with chemicals and test equipment for a 1-year term after Substantial Completion.

3.2.2.2 Provide a minimum of 1 service call per month after Substantial Completion and all necessary supervision of cleaning procedures and monitoring of treatment program prior to construction completion. Submit written reports on all activities and testing results achieved in servicing this location.

3.3 WATER TREATMENT SERVICE PROVIDER

3.3.1 Provide a minimum of 1 service call per month after Substantial Completion and all necessary supervision of cleaning procedures and monitoring of treatment program prior to construction completion. Submit written reports on all activities and testing results achieved in servicing this location.

3.3.2 Inspect any system or equipment when open for waterside inspections as requested by customer, at no additional charge.

3.3.3 Provide immediate emergency service response at no additional charge.

3.3.4 Manage and maintain on-site chemical inventories. Responsible for removing from premises all empty water treatment chemical containers, in a timely manner.

3.3.5 Maintain MSDS binder in compliance at all times.

3.3.6 Provide/maintain logbook for data collection

3.4 GENERAL

3.4.1 The chemical supply company shall instruct the Owner's operating staff (minimum 2 hours of training) before acceptance of the installation by the Consultant. Supply copies of training material, written instructions of the treatment dosages, control charts and test procedures.

3.4.2 Chemical supply company must supply written reports, submitted to the site consultant indicating progression of job status as well as PROOF of implementation of requirements within this specification.

3.4.3 Specification MUST be followed as designed and must NOT deviate from this outline.

3.4.4 Central Cooling Water is treated by the University at Central Chiller Plants. For CCW treatment, notification must be given to the Utilities Division of the startup date/time and total system.
15600 Refrigerants

1. In accordance with the Montreal Protocol on substances that deplete the Ozone layer, all new refrigerating, cooling and air conditioning equipment shall not contain any CFC nor HCFC based refrigerants nor mixtures of such refrigerants.

2. Major chillers MUST operate with 134/A refrigerant

3. Refrigerant Monitoring Systems must be by Arjay.

15700 Access Doors

1. Provide access doors/panels in solid ceilings so that the equipment and the various components that must be serviced, may easily be reached. The doors/panels should be centered on the items to be serviced and be of adequate size to allow removal of the service parts. In no case shall the size of access door be less than 24” x 24”. Provide access panels associated with each fire/smoke damper.

2. Where devices such as reheat coils are mounted in the ducts, access openings must be installed in the duct in front of and behind the device to facilitate cleaning and maintenance.

15720 Air Handling Equipment

1. Provide internal waterproof lighting in all accessible air handling unit compartments.

2. Provide hinged access doors to the equipment compartments, with latching hold-open devices and door handles on both sides of door. Ensure no interference of pipings and access doors with respect to coil removal space.

3. For all outside air systems, face and by-pass type dampers with anti-stratification mixing section shall be used when freeze protection freeze-stat is required.

4. Ensure that construction and equipment installation allows space sufficient for the removal of coils from the air handling units. Such allotted coil removal space should be indicated on the drawings. Provide lifting facilities such as eye bolts, I-beams and A-frames for coils heavier than 200 lbs.

5. Variable frequency drives shall be used for fans to vary air flow, rather than inlet vane control. Provide electronic filter circuits to suppress electronic noise and harmonics generated by the device.

6. Fan bearings shall be lubricated externally. Do not use remote grease pipings or tubings.

7. Fan drives: V-belt shall be industrial grade. Multi-sheave belts shall be "power bands".

8. Cooling coils shall have stainless steel frame rather than galvanized steel frame; if not available, advise U. of T. representative.

9. Moisture eliminators are mandatory and shall be made of stainless steel

10. Provide moisture evacuation facilities for all cooling coils drained for the heating season. (See Appendix ‘C’ Diagram #15.1). Connections to the pipe shall be by ‘Threadolet’.

11. Provide local isolation valves for coils where possible.

12. Drain pans in built-up air handling units should be constructed of stainless steel of appropriate gauge. Pans shall slope down to drain. Drain trap height shall exceed maximum fan suction static pressure at dirty filter condition.

13. 14 Gage checker plate floor shall be installed on the base. Floor shall be flat, reinforced from below, with all seams continuously welded. The base shall be insulated with 2” (50 mm) 1-1/2 Lb/ft3 fibreglass under the floor.
14. All external louvers shall be constructed of galvanized steel and include a galvanized steel bird screen. Prefinished anodized aluminium louvers will be considered as an alternative.

15. A Dwyer Magnehelic pressure gauge shall be provided in main supply air ducts near fan discharge, to indicate dropped fire dampers or other obstructions in the supply duct system.

16. Do not use aluminium ductwork for corrosion resistance within supply air systems downstream of humidifiers. Stainless welded is acceptable.

17. Noise control shall comply with noise criteria (N-C) standards of noise measurement. The space noise levels shall comply with ASHRAE guidelines. Noise levels shall be measured by an independent acoustic consultant as directed by U. of T.

18. Duct configurations located upstream and downstream of air velocity measuring stations shall be sized adequately in accordance with manufacturer’s installation guide and recommendations. Operating air velocity shall not be less than 700 feet per minute.

19. Air Filters for General Office Buildings

19.1. Provide air filters of the appropriate type for the application.

19.2. Filters shall be purchased from UofT incumbent supplier.

19.3. Test method for all particulate filters shall conform to ASHRAE Standards #52.2-2007B or later revision, including ‘Appendix J’ and test results shall be provided.

19.4. Filters shall have Class 2 fire rating by Underwriters Laboratories of Canada or be classified as UL900.

19.5. Manufacturer shall provide evidence of facility certification to ISO 9001:2000

19.6. Prefilters:

19.6.1. 24"x24"x2" thick, polyester media pads with average synthetic dust weight arrestance of not less than 75% and dust holding capacity of not less than 125 grams, both at a final pressure drop of 1" w.g. and a face velocity of 500 F.P.M. Equivalent to AAF VA Blue

19.7. Medium Efficiency Filters:

19.7.1. Air filters shall be medium efficiency ASHRAE pleated panels consisting of lofted media blend, welded wire media support grid, and beverage board enclosing frame. Sizes shall be noted on drawings or other supporting material.

19.7.2. Construction:

19.7.2.1. A welded wire grid, treated for corrosion resistance shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation.

19.7.2.2. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

19.7.3. Performance:

19.7.3.1. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2-2007B (or later revision). It shall also have a MERV 8A rating when tested per Appendix J of the same standard. The media shall maintain or increase in efficiency over the life of the filter.

19.7.3.2. Initial resistance to airflow shall not exceed 0.23", 0.31" or 0.27" w.g. at an airflow of 350, 500 or 500 fpm on 1", 2" or 4" deep models respectively.

19.7.3.3. Filter shall be warranted by manufacturer to last at least 4380 hours @ 1970 cfm, and 1.0” w.g. under normal operating conditions in the case of 2” depth filter.

19.7.3.4. Manufacturer shall guarantee the integrity of the filter pack to 2.0” w.g.

19.8. High Efficiency Final Filters:

19.8.1. 24”x 24”x12” deep rigid fixed pleated media type with 80% minimum dust spot efficiency
and 95% arrestance per ASHRAE 52.1-92 test method. Minimum efficiency reporting value (MERV) of 13 per ASHRAE Standard 52.2-2007. Equivalent to AAF Varicel or equal.

19.8.2. Air filters shall be high efficiency ASHRAE extended surface pocket style filters consisting of high loft air laid microfine glass media, a reinforced ABS plastic header, ABS plastic pocket retainers, and bonding agents to prevent air bypass and ensure leak free performance.

19.8.3. Sizes shall be as noted on drawings or other supporting materials. Performance values for reference purposes shall be based upon 24-inch by 24-inch by 21 or 22-inch 10-pocket model.

19.8.4. Construction:

19.8.4.1. Filter media shall consist of high-density air laid lofted microfine glass media that is chemically bonded to a micro mesh media support backing forming a lofted filter blanket.

19.8.4.2. All stitching centers shall be sealed through the use of a foam based sealant that shall remain pliable throughout the life of the filter.

19.8.4.3. Pockets shall be formed into tapered pleats, supported by controlled media space stitching, to promote uniform airflow across the surface of the media. The pockets shall also have a conical configuration to minimize contact with HVAC system components.

19.8.4.4. Support members shall include an ABS plastic header and ABS plastic pocket retainers that may be either recyclable or incinerable to promote sustainability. The header shall be joined to the media to prevent air bypass. The frame shall form a rigid and durable support assembly.

19.8.4.5. The air exiting side of the air tunnels include a pocket flange to ensure pocket integrity throughout the life of the filter. A downstream pocket-to-pocket partition shall provide additional pocket separation to ensure full flow through the entire media area.

19.8.4.6. A filter-to-filter sealing gasket shall be installed on one of the vertical members of the filter header.

19.8.5. Performance:

19.8.5.1. The filter shall have a Minimum Efficiency Reporting Value of MERV 13 per ASHRAE Standard 52.2 2007B (or later revision), Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. It shall further have a MERV 13A rating when tested under Appendix J of said standard.

19.8.5.2. Initial resistance to airflow as listed by the manufacturer on a 21” or 22” depth 10-pocket bag shall be a maximum of 0.40” w.g at an airflow of 500 fpm.

19.8.5.3. The manufacturer shall warrant that the filter shall be capable of withstanding 10.0” w.g. without failure of the filter.

19.8.5.4. Filter shall be warranted by manufacturer to last at least 8760 hours @ 1970 cfm and 1.0” w.g., without the requirement of a pre-filter, under normal operating conditions in the case of up to 12” pocket depth; 13140 hours for a 13”- 22” depth pocket; twenty-four 17520 hours for a 23”- 32” depth. In all cases this warranty shall apply without the requirement of a pre-filter, and filter shall not exceed 1” w.g. at an airflow of 500 fpm at the end of these in-service periods. Filter shall further be warranted to maintain rated efficiency throughout its service life.

19.9. Supporting Data:

19.9.1. Provide complete ASHRAE test report per ASHRAE Standard 52.2-2007B (or later revision) including full testing per Appendix J of this Standard by an INDEPENDENT TESTING LABORATORY that participated in the ASHRAE Research Project RP-1088 (Coordinate and Analyze Interlaboratory Testing of Filters under ASHRAE Standard 52.2 to Determine the Adequacy of the Apparatus Qualification Tests).

19.10. Product shall be Camfil Hi-Flo ES or approved equal.

19.11. Filter Warranty Requirement:

19.11.1. If a bank of filters within the AHU causes the w.g. to exceed 1.0” at an airflow of 500 fpm, under normal operating conditions (as deemed by the University’s Operations staff)
19.11.2. during the warranty period, a new set of filters of the same specification will be supplied to the University at the Vendor’s expense. These filters will be warranted for the balance of the original warranty period.

19.12. Filter Frames:

19.12.1. Frames shall be constructed of 16 gauge galvanized steel at least 3 inches deep and permanently assembled with solid rivets.

19.12.2. Where possible, the prefilters and afterfilters shall be installed in separate frames allowing the final filters to be replaced without having to remove the prefilters.

19.12.3. Closed cell gasketing shall be included allowing a tight seal to filter header/frame.

19.13. Magnehelic type differential pressure gauge with BacNet connectivity shall be provided across each air filter bank

15760 Hydronic Radiator Installation

1. Provide a hose bib drain at all radiators that have supply and return mains above the radiators, and on any other radiator that will not drain through its piping.

2. Provide automatic air vents and air separators at high spots in the piping systems.

3. Provide a shut-off valve at supply and return connections of radiator. Provide separate balancing valve or shut-off valve with memory position.

15830 Fume Hood Exhaust Fans / Environmental Compliance Approval (ECA)

1. Fume Hood Ventilation Guidelines:
   The following guidelines shall be used as a checklist of items to be considered. The consultant shall refer to the standards and codes for specific requirements.

   1.1 Systems shall comply with U of T Environmental Health & Safety specifications, which can be found at the following link under item “Laboratory Fumehood Standard”: Policies and Procedures Listing

   1.2 Give consideration to use of energy conservation systems incorporating common exhaust ducting, VAV hoods and reduced face velocity standby operation.

   1.3 Radioisotope and perchloric acid fume hoods shall be separately ducted to outside; the design and construction shall incorporate precautions for safety.

   1.4 Exhaust stacks shall discharge vertically upwards at approved exit velocity and of sufficient height and so positioned as to ensure that emissions are unable to re-enter the building, and adjacent buildings.

   1.5 A drain connection system shall be provided at fan low point.

   1.6 Air filters, if installed, shall be as close as possible to the fume hood.

   1.7 Do not connect a fume hood to an existing fume hood duct, unless cleared with Environmental Health and Safety, and Utilities. Ensure air balancing is checked.

   1.8 Stack supports, stainless steel guy wires and attachment points are to be designed by a registered structural engineer. Provide identified yellow protective sleeves on guy wires.

   1.9 Label each stack with corresponding room number and exhaust hood number.

   1.10 Label each isolating disconnect as to voltage and source of supply, (e.g., PANEL ABC - CIRC 7) and ensure that source breaker is identified as to load (e.g., AC#7 Roof).
2. **Environmental Compliance Approval**
   2.1. Each fume hood, fume hood fan or fume hood stack that is to be added or modified shall be compliant with existing Environmental Compliance Approval.
   2.2. Before the project can proceed, the University of Toronto Office of Environmental, Health and Safety shall be notified of any proposed additions or modifications and given all planning details and drawings in order for them to determine compliance or the need for amendment to an existing ECA.
   2.3. The University of Toronto Office of Environmental, Health and Safety shall be made aware of all chemicals that:
      2.3.1. Are currently being used in the laboratory containing or will contain the fume hood.
      2.3.2. Will be used in the laboratory containing or will contain the fume hood.

3. **Labeling**
   3.1. All fume hoods must be labeled numerically (ascending from 1) based on the number of fume hoods located in a lab. The label must indicate which mechanical room contains the corresponding fume hood fan.
   3.2. All fume hood fans must be labeled with the associated fume hood room number and fume hood number (or numbers if the fan is connected to multiple fume hoods).
   3.3. All fume hood exhaust stacks must be labeled with the associated fume hood room number and fume hood number (or numbers if the fan is connected to multiple fume hoods).

15840 **Air Terminal Units**
1. Ensure that access is provided to each air terminal unit, including VAV and CV boxes, as appropriate to enable the carrying out of periodic cleaning of the reheat coil and inlet screen.
2. VAV boxes minimum airflow settings shall comply with ASHRAE recommended values and required matching reheat coils shall comply with latest OBC/ASHRAE requirements.

15850 **Air Distribution**
1. When duct thermal insulation is required, it shall be of external type only.
2. Due to the cleaning requirements for the ducting, no internal acoustical lining is allowed. Use appropriate noise silencers instead.
3. Internal acoustical insulation may be used for transfer ducting only.
4. Under floor air distribution systems shall be supplied with floor mounted plenum separations. Press-fitted plenum dividers are not acceptable. Air tight air plenums are essential. Caulk sealing is required around the plenum.
5. Air flow straightener turning vanes shall be installed in all cases where 90 degree square main ducts are used.

15915 **Electrical Work**
Electrical power and control wiring for mechanical equipment and systems shall comply with the following requirements:
1. **Motor Starters and Motor Control Centres**

   **Combination Across the Line Magnetic Motor Starters**

   1.1. Combination starters shall be CSA certified

   1.2. Combination magnetic starters shall be complete with the following:

   - 1.2.1. Main circuit breaker (fuses not acceptable) sized to provide motor short circuit protection and meet system interrupting capacity. Circuit breaker operating handle shall be lockable in the open position
   - 1.2.2. Magnetic contactor
   - 1.2.3. Overload relays, one per phase
   - 1.2.4. Sprinklerproof enclosure for stand alone starters
   - 1.2.5. Primary and secondary fused control transformer having 120vac secondary rating and 100 watt spare capacity. Fuses shall be type CC time delay
   - 1.2.6. Hand-Off-Auto selector switch
   - 1.2.7. Running LED type pilot light (red)
   - 1.2.8. Reset Button
   - 1.2.9. Minimum two sets of Form C auxiliary dry contacts in mylar enclosure and wired to a terminal strip within the starter for remote status wiring connections
   - 1.2.10. Prewired control relays compatible with thermistors where motors are provided with thermistors wired to initiate immediate motor shutdown in the event of thermistor operation. Provide a separately identifiable LED type pilot light to indicate when a control relay has been operated by a motor thermistor together with a separately identifiable reset button for resetting the control relays. Wire the relay activation circuit to a terminal strip within the starter for connection to the motor thermistor wiring
   - 1.2.11. Terminal strip within the starter for termination of all external protection and control wiring (e.g.: remote firestat, freezestat)
   - 1.2.12. Provide accurate schematic permanently affixed to the inside of door showing all internal and external wiring connections
   - 1.2.13. Provide defeat mechanism to access starter without having to de-energize starter
   - 1.2.14. Starter components shall be readily accessible for replacement and shall not require major component replacement to repair or access a minor component
   - 1.2.15. A lamacoid plate shall be affixed to the starter cover with stainless steel screws, identifying load supplied, voltage rating, and source of supply. For starters on normal supply, letter shall be black on white background. For starters on emergency supply letters shall be white on green background.
   - 1.2.16. Starters shall be of North America manufacture and of the same manufacturer

2. **Variable Frequency Drive Starters**

   **General**

   2.1. Variable frequency drives shall be CSA certified

   2.2. Drives shall be of the adjustable frequency totally digital pulse width modulated type

   2.3. Drives shall be suitable for use with high efficiency motors

   2.4. Drive enclosures shall be rated NEMA 12 UL Type 12 and shall be UL listed as a plenum rated VFD,
2.5. Drives shall be provided with an isolation 'service switch' and an Auto-Off-Bypass selection feature (keypad, selector switch) mounted on front face/door together with a red LED running light

2.6. The bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair/ replacement

2.7. Drives shall interface via terminal block (s) for connection of all external wiring. Hardwire connections between drive and external wiring are not acceptable

2.8. Drives shall have an accurate schematic wiring diagram permanently affixed to the inside of door showing all internal and external wiring connections

2.9. A door defeat mechanism shall be provided to open door to access drive components when the main disconnect switch is in the closed position

2.10. Drive components shall be readily accessible for replacement and shall not require major component removal nor replacement to repair or access a minor component

2.11. Drives shall have a sticoid plate affixed to the cover with stainless steel screws, identifying the load supplied, and in the case of standalone drives (not installed in an MCC), shall also indicate voltage rating and source of supply. For drives on normal supply, letters shall be black on white background. For drives supplied from an emergency power source during normal power supply outage, letters shall be white on green background

2.12. Drives shall be manufactured by ABB or acceptable equivalent.

Performance:

2.13. Drives shall be designed to operate at rated voltage +/- 15%, 3 phase, 60 Hz input power supply and rated motor voltage output at 0.5 to 60 Hz output. Transformers shall not be used to achieve rated voltage inputs and outputs.

2.14. The total harmonic distortion for any particular installation must be less than 5%.

2.15. Drives shall have a continuous duty service factor of 110% of rated motor current.

2.16. Drives shall have a minimum efficiency of 98% at maximum load and speed

2.17. Drives shall have a minimum line side displacement power factor of 0.98 at all speeds

2.18. Drives shall meet all performance requirements to a maximum of 40 degrees C, 95% maximum non condensing humidity, and maximum 1000 metres ASL

2.19. Drives shall have adjustable minimum speed of 0-80% and adjustable maximum speed of 50-110%

2.20. Drives shall have separately adjustable acceleration and deceleration ramps from 1 to 999 seconds (0 to 110% speed)

2.21. Drives shall automatically initiate motor restart when a momentarily or prolonged power interruption has occurred and been restored and provided a run enable signal is present. The motor shall restart at the speed at which it is rotating and accelerate to the speed called for by the last speed reference signal

2.22. Drives shall be provided with a 30 Hz ride through

2.23. Drives shall be capable of operating for setup and testing without a motor connected
Protection:

2.24. Drives shall be provided with main horsepower rated disconnect switch to isolate the drive. Switch handle shall be accessible on the front of the drive and padlockable in the closed and open positions.

2.25. A combination circuit breaker and contactor shall be provided on the load side of the main disconnect switch for supply of the motor in Auto mode. A combination circuit breaker and contactor shall be provided also on the load side of the main disconnect switch for supply of the motor in bypass mode. Circuit breakers shall provide motor and drive short circuit protection and meet system supply available short circuit rating.

2.26. Drive contactors shall be horsepower rated and match the motor maximum horsepower rating.

2.26.1. Drives shall be provided with line over and under voltage protection, phase loss protection and phase unbalance protection to trip the drive off whether in Auto or Bypass mode.

2.26.2. Drives shall have thermal overload protection to trip the drive off should a motor overload or stall condition occur in either the Auto or Bypass mode.

2.26.3. Drives shall have internal over temperature protection to protect the internal drive components and trip the drive off in the event of over temperature.

2.26.4. Drives shall have 3 phase thermistor relay protection for connection to external motor thermistors in motors 100HP and larger. Should a relay operate, the drive controller shall shut down whether in Auto or Bypass mode, and a separate LED on the front of the door shall indicate “Motor Overtemp.”

2.26.5. Drives shall be provided with input transient protection in the form of line reactors to prevent drive damage from line transients on the power distribution system.

2.26.6. Drives shall be able to accept a remote isolation of the motor (e.g.: remote motor disconnect switch operation) while motor running without causing damage to the drive whether running in the Auto or Bypass mode.

2.26.7. Drive control and logic supply transformers shall have primary and secondary fusing. Fuses shall be Type CC time delay.


2.26.9. Drives shall be provided with an Auto-Off-Bypass selector switch on the front of the door together with a red LED running light.

2.26.10. Drives shall have a regulated 24 VDC power supply for output connection to remote sensors requiring power to supply drive input control.

2.26.11. Drives shall have a signal follower for interface connection to both 4-20ma and 0-10VDC remote inputs from remote sensors controlling drive in the Auto mode.

2.26.12. Drives shall have interface connection to the University Enterprise Management and reporting System (EMRS) using BACnet – 135 communication and interoperability protocols through the BAS:
   2.26.12.1. Bacnet IP
   2.26.12.2. BACnetMS/TP
   2.26.12.3. MODBUS RTU
   2.26.12.4. Proprietary

2.26.14. 4-20MA output when in Auto and Bypass for remote monitoring

2.26.15. Remote dry contact from BAS for run command in the Auto mode

2.26.16. Dry contact for connection to BAS to indicate VSD shutdown (fault condition)

2.26.17. Drives shall be have interface connection to remote safety interlocks (e.g.: firestat, freeze-stat, etc) in Auto and Bypass modes
   2.26.17.1. Drives shall be provided with external interlock contact connection for run control in either the Auto or Bypass mode
   2.26.17.2. All readout information shall be displayed on a high resolution dot matrix alpha-numeric high resolution LCD display. Information shall be presented in descriptive user friendly format. Coded and abbreviated displays are not acceptable
   2.26.17.3. All readout information shall be readable at the EMRS and includes at a minimum;
      2.26.17.3.1. Amps per phase
      2.26.17.3.2. Volts per phase
      2.26.17.3.3. Kilowatt-Hours
      2.26.17.3.4. Reactive power
      2.26.17.3.5. Real Power
      2.26.17.3.6. Time stamps

2.26.18. Direct keyboard entry shall enable display of and password enable changing of the following parameters:

2.26.19. Maximum speed setting

2.26.20. Minimum speed setting
   2.26.20.1. Acceleration rate
   2.26.20.2. Deceleration rate
   2.26.20.3. Current limit-monitoring
   2.26.20.4. Current limit-regenerating
   2.26.20.5. Up to 3 preset speeds
   2.26.20.6. Up to 3 frequency points to avoid resonant speeds
   2.26.20.7. Direct keyboard entry shall enable display of the following to permit diagnostic troubleshooting:
      2.26.20.8. Lockout and cause
      2.26.20.9. Line under/over voltage, phase loss/unbalance
      2.26.20.10. Drive overtemperature

2.26.21. Motor thermal overload trip
   2.26.21.1. Motor thermistor trip operation
   2.26.21.2. Invertor DC bus over/under voltage
   2.26.21.3. Loss of 24VDC for remote sensing devices
2.26.21.4. Output fault on any one phase including phase identification  
2.26.21.5. Missing or zero speed reference  
2.26.21.6. Trip caused by external interlock  
2.26.21.7. Direct keyboard entry shall enable display of the following:  
2.26.21.8. Power on  
2.26.21.9. Ready  
2.26.21.10. Running  

2.26.22. Jogging  
2.26.22.1. Motor accelerating  
2.26.22.2. Motor decelerating  
2.26.22.3. Direction of rotation  
2.26.22.4. Selection status (auto, off, bypass)  
2.26.22.5. Current limit  
2.26.22.6. Direct keyboard entry shall enable a manual (non-permanent override control of preset memory settings) control of the following control functions:  
2.26.22.7. Run  
2.26.22.8. Stop  
2.26.22.9. Jog  

2.26.23. Acceleration and deceleration speed  
2.26.23.1. Speed set  
2.26.23.2. Direct keyboard entry shall enable non erasable nonvolatile memory display of the last 30 drive shutdowns and include the following data:  
2.26.23.3. Date, time, and elapsed time of shutdown  
2.26.23.4. Cause of shutdown  
2.26.23.5. Output frequency, voltage and load at time of shutdown  

2.26.24. Accelerating or decelerating at time of shutdown  
2.26.24.1. Motor Control Centers  
2.26.24.2. Motor control centres shall comply to the latest CSA requirements.  
2.26.24.3. MCC’s shall be sprinklerproof construction, free-standing, front access, Class II type B, with rms current interrupting rating to suit and comply with and include the following:  
2.26.24.4. Closed, dead front construction  

3. Main breaker  
3.1. 3.2.3 Tinned copper main bus  
3.2. 3.2.4 Tinned copper vertical bus in each section  
3.2.5 Continuous ground bus  
3.2.6 Full height barrier to isolate the vertical bus from the starters  
3.2.7 Full height wiring trough with cable supports for wiring for power and control wiring
3.2.8 Line and control terminal blocks, each with 20% spare capacity

3.2.9 Starters and disconnects shall have free floating, self-aligning construction with silver-to-silver contact. Each starter and disconnect shall be capable of being removed with the remainder of the MCC still energized.

3.2.10 Where spaces are noted for future, provide each space with blank cover, rails and necessary hardware to allow a starter or breaker to be installed and connected at a later date without changes to the internal distribution.

15950 Testing, Adjusting and Balancing

Testing and Balancing of Piping and Air Systems:

This work may be tendered and contracted separately to appropriately divorce it from the Mechanical construction contract. This separate contract should include the stratification testing and adjustments.

Design flow rates on VFD systems shall be accomplished with the VFD operating at 55-58 Hz

Systems shall be balanced to AABC or NEBB standards

Check Airflow capacity to ensure that at filter simulated maximum (dirty filter) differential pressure, maximum design flow values are able to be maintained.

1. Reported measurements shall be subject to verification by the Commissioning Authority (CA). Provide instrumentation and manpower required to verify results of up to 30% of all reported measurements. The number and location of the verified measurements to be at the discretion of the CA. A measured deviation of more than 10% between the verification reading and the design value shall be considered unacceptable.
## LIST OF MANDATORY and PREFERRED MANUFACTURERS

<table>
<thead>
<tr>
<th>Canadian Master Format</th>
<th>Item # and Name</th>
<th>Manufacturers and Models</th>
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<tr>
<td>1995</td>
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<td>15120</td>
<td>Non-Buried Valves:</td>
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<td></td>
<td>15130</td>
<td>Domestic Hot and Cold</td>
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<td>15140</td>
<td>Back Flow Preventers</td>
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<td>15190</td>
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<td></td>
<td>15210</td>
<td>Battery Exposed Flush Valves</td>
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<tr>
<td></td>
<td>15220</td>
<td>Battery Deck Faucets</td>
</tr>
</tbody>
</table>

### #3.2 Steam Drip Trap Valves
- **Mandatory**
- Manufacturer: Velan
- Model: ¾” WO4-2054T-02TS Bellows sealed valves

### #4 High Pressure Steam Drip Traps
- **Mandatory**
- Manufacturer: Bestowel
- Model: DM-25, bimetallic type

### H&A/C- Chilled Water (buried)
- **Mandatory**
- Manufacturer: Ricwil
- Approved

### General: Rad. Valves
- **Mandatory**
- Manufacturer: Braukman, or equivalent

### Non-Buried Valves: Domestic Hot and Cold water
- **Mandatory**
- Manufacturer: Challenger
- Model: Gate, or Globe butterfly valves

### Back Flow Preventers
- **Mandatory**
- Manufacturer: Watts

### Steam Traps: Low Pressure Steam
- **Mandatory**
- Manufacturer: Spirax-Sarco
- Type: Float and Thermostatic Traps
- Rad Traps: Spirax-Sarco or Dunham-Bush

### Pressure Reducing Valves
- **Mandatory**
- Manufacturer: Masoneilan
- Model: Series 500
- or
- Manufacturer: Fisher
- Model: 655 or 93B or C

### Variable Orifice Steam Metering
- **Mandatory**
- Manufacturer: Spirax-Sarco
- Model: Gilflo

### Battery Exposed Flush Valves
- **Mandatory**
- Manufacturer: Delta ‘‘Teck’’ Flush Valve
- Toilet: Model DEL81T201BTA
- Urinal: 3.8 Litre, model DEL81T231BTA-38
- 1.9 Litre, model DEL81T231BTA-19 (recommended)
- 0.5 Litre, model DEL81T231BTA-05 (not recommended where building drains don’t allow a clear flow discharge)
- Manufacturer: Moen
- M-Power #8311 – Sensor operated closet FV – (1.28 gpf/4.28lpf)
- M-Power #8315 – sensor operated urinal FV – (0.5 gpf/1.9 lpf)
- M-Power #8305 – Sensor operated lavatory faucets.

### Battery Deck Faucets
- **Mandatory**
- Manufacturer: Delta
- 8” CENTER SET: Model DEL590T1850
- 4” CENTER SET: Model DEL590T1250
- SINGLE HOLE: Model DEL590T1150
- (also available in hard wired)

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CONTINUED ON NEXT PAGE
### PREFERRED/MANDATORY MANUFACTURERS

<table>
<thead>
<tr>
<th>Item # and Name</th>
<th>Manufacturers and Models</th>
</tr>
</thead>
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<tr>
<td>Mixing Valves</td>
<td>Manufacturer: <strong>DELTA</strong>&lt;br&gt;Models: R2900MIX; R2470MIX</td>
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<td>#1 Drinking Fountains</td>
<td>Manufacturer: <strong>Elkay</strong>&lt;br&gt;Model: EZH20</td>
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<tr>
<td>#1 Sump Pumps</td>
<td>Manufacturer: <strong>Gorman Rupp, or Gould Pumps, or equivalent</strong></td>
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<tr>
<td>#2.3.5 Cooling Tower Control</td>
<td>Manufacturer: <strong>Micrologics Control System</strong></td>
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<td>#2.3.7 Chemical Feed Pumps</td>
<td>Manufacturer: <strong>Pulsatron</strong></td>
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<tr>
<td>#2.3.8 Make Up Water Meters</td>
<td>Manufacturer: <strong>Jesco</strong></td>
</tr>
<tr>
<td>#16 Air Handler Unit: Pressure Gauges</td>
<td>Manufacturer: <strong>Dwyer</strong>&lt;br&gt;Model: Magnehelic</td>
</tr>
</tbody>
</table>
Appendix ‘B’

Diagram 15.1: Chilled Water Coil Moisture

RUN FLEXIBLE DUCT NEARLY OVER TO COIL FROM SYSTEM SUPPLY DUCT. LENGTH OF FLEX DUCT AS REQUIRED.

S.A. DUCT
SHUT-OFF DAMPER

CLAMP

COIL/PIPE SYSTEM ISOLATING VALVE

CHW RETURN

CHW SUPPLY

DIRT LEG

AIR FLOW

CHILLED WATER COIL

AIR VENT (TYP.)

2" BLOWOUT CAP.
C/W REDUCER TO SUIT COIL CONN. SIZE

2" BLOWOUT CAP.
C/W REDUCER TO SUIT COIL CONN. SIZE

CHILLED WATER COIL MOISTURE EVACUATION
Appendix ‘C’  
Control Air Filtration Station
Appendix ‘D’
Sample installation condensate meter
1 EXECUTIVE SUMMARY

1.1 Scope

The University of Toronto is committed to reducing its scope 1 and 2 greenhouse gas (GHG) emissions to at least 37% below its 1990 level - a reduction of 43,275 tonnes eCO₂ from 116,959 tonnes eCO₂ by 2030 in absolute terms. Furthermore, U of T is targeting to be a net-zero GHG institution by 2050. To accomplish this, the University has retired the previous Energy Performance and Modelling Standard (April 1, 2019) and introduced this now-governing Tri-Campus Energy Modelling & Utility Performances Standard (July 1, 2020).

1.2 Application

This standard provides project-specific energy and water efficiency targets in new and renovation projects, calculates energy and GHG project budgets and introducing a streamlined modelling, benchmark comparison, documentation submission and approvals approach. All projects that develop a PPR or renovation project initialization process as of July 1, 2020 must adhere to these standards. Note that projects following the previous standards (April, 2019) must show still how they would meet the requirement to be “40% better than” ASHRAE in order for the U of T Implementation Committee to decide whether or not to pursue that option as specified in the 2019 standards.

1.3 Promote Innovation

This standard is meant to inspire innovative designs based on absolute energy and GHG targets that calculate energy and GHG performance budgets, according to the year the building is scheduled to be occupied along with archetypical program use (entered as NASMs and converted to GSM through an approved gross up factor). The targets ratchet down predictably over time as codes, cost-effective technologies, designs and delivery methods improve. The University is interested in innovative designs that promote resiliency, sustainability, well-being and low carbon and energy solutions.

1.4 Energy and GHG Performance Charter

The tool used to define the targets and budgets is called the “Charter”. The Charter calculates the utility targets as energy and GHG utilization indices which are then used to estimate the annual performance budgets. The NASMs of the archetypical space use in each design is input to the Charter and completed by U of T staff during the PPR stage and before the call for design tenders is issued. The final GSMs are calculated using approved gross up factors applied to the NASMs. Final energy and GHG utilization indices are calculated using GSMs.

1.5 Scheduled Occupancy

The energy and GHG performance targets for all projects are defined for the year that occupancy is scheduled in the project planning reports. If the actual occupancy is delayed for any reason, the original scheduled occupancy date and targets will hold for the purposes of performance approvals.
1.6 Documentation Steps

The approved energy modelling procedures will be used to calculate the energy and GHG performance targets and budgets for the designs and compared to the Charter targets throughout the design stages described in Tables 1.14.1 and 1.14.2.

1.7 Targets and Budget Steps

The 2020 – 2022 targets (Table 1.12.1) form the basis for the subsequent targets. During the development of these standards, archetype buildings were used that represent the majority of structures/spaces within the university portfolio. These archetypes were used to prepare models and reductions calculations using existing technologies (at 2019). The targets for 2022-2026 (Table 1.12.2) are, on average, 8% lower than Table 1.12.1 in terms of absolute energy and GHG indices. The targets for the 2026-2030 (Table 1.12.3) are 20% below those in Table 1.12.2. As a comparison, these targets are in line with the Toronto Green Standards v3, between Tier 3 and Tier 4 at each step with adjustments to reflect campus archetype specifics. This will ensure U of T will maintain a leadership role and be ahead of the TGS steps every four years.

1.8 Modelling as Performance Estimates

These Standards and resulting models are not post-occupancy energy or GHG predictions. They are to be used to establish and track energy and GHG use indices compliance during the design process and as a comparative tool for building baseline and performance evaluation. The intention is to narrow the gap between predicted energy use and actual performance. The U of T will use the modelling results to assess post-occupancy performance. *If the actual energy performance, after 12 months of continuous operation, exceeds the predicted performance by more than 15%, the design team/modelers will be asked to comment and assist U of T to determine the possible reasons for the variation.*

1.9 Codes and Standards in effect at time of Scheduled Occupancy

Throughout, whenever Codes, Guidelines or Standards are referenced, they are to be those during the assigned Charter year of scheduled occupancy. For example, these standards, the Ontario Building Code, Toronto Green Standards and ASHRAE revise their criteria toward more stringent levels of performance regularly, usually every four years.

1.10 Anticipate Future Code/Standards

Realizing we will not know these changes until they are released, the design teams are to anticipate improved energy performance and low carbon metrics based on the targets described in these standards and the year of occupancy. Estimates of the impact of these future standards, codes and guidelines shall be presented to the U of T Implementation Committee for consideration. In all cases, higher performance targets shall be the default design mandate.

1.11 LEED™ and other High Performance Guidelines

LEED™ Silver is to be the minimum level for any projects that are using/referring this program. It is not a U of T requirement that projects are certified. For the purposes of these Standards, the points in the “Optimize Energy Performance” and “Enhanced Commissioning” within the “Energy & Atmosphere” category are to be maximized.
Any other high performance guidelines that are specified and complied to, e.g., WELL, PassivHaus, CaGBC Zero Carbon building standards will be announced in the PPR and indicated in any subsequent requests for proposals.

1.12 Greenhouse Gas Emissions and System Efficiency Factors

GHG emissions factors (EF) and distributed energy systems efficiencies are based on factors as of 2020. The EF’s in Section 7.10 shall be used for GHG indices predictions in all target periods and will be adjusted to the actual factors when they become known at the time of the Charter configuration. EF’s, district energy system efficiencies, equipment efficiencies and heat pump coefficients of efficiency shall be approved by U of T Implementation Committee before used in any modelling.

1.13 Calendar Years

Calendar years are used throughout these Standards (January 1 – December 31) when referencing target periods and scheduled occupancy dates. The year when the project is defined to be occupied (in the PPR, requests for tenders, project initialization) will define the performance targets and energy/GHG budgets.

1.13.1 New Construction: Targets for Scheduled Occupancy Dates between 2020 to 2022

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Thermal energy Source</th>
<th>TEUI - Heating (ekWh/m²/yr)</th>
<th>GHGI - Heating (kg eCO₂/m²/yr)</th>
<th>TEDI - Heating (ekWh/m²/yr)</th>
<th>TEDI - Cooling (ekWh/m²/yr)</th>
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<td>Academic</td>
<td>District Energy</td>
<td>105</td>
<td>16</td>
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<td>80</td>
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<td>75</td>
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1.14 District energy and non-district energy systems

“District Energy” refers to thermal energy, in particular steam or med/high temperature water (>60°C), delivered to the building from a central utility plant that uses natural gas as the primary fuel. Unless otherwise specified by U of T, the Central Plant heating annual efficiency is defined as 80%; Central cooling plants shall use a COP of 5.

For sites not connected to a central utility plant, Non-District targets are to be used. For sites connected to a central
heat pump network or heat recovery network (e.g., Sofame at St. George) use Non-District targets. In the case of ground source heat pumps and central chiller plants, proposed plant efficiencies/coefficient of performance shall be presented to and approved by U of T.

1.14.1 New Construction: Targets for Scheduled Occupancy Dates between 2022 to 2026

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Thermal energy Source</th>
<th>TEUI (kWh/m²/yr)</th>
<th>GHGI (kg eCO₂/m²/yr)</th>
<th>TEDI - Heating (kWh/m²/yr)</th>
<th>TEDI - Cooling (kWh/m²/yr)</th>
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</table>
1.15 Renovations

The renovation of existing buildings plays a critical part in U of T’s plan to achieve the established 2030 GHG emission reduction target. For example, in order to meet our 2030 goals on St. George Campus, the average GHG (2020) intensity ~69e kWh/m² must be reduced by ~50% to < 32 e kWh/m². This Standard identifies utility performance requirements and targets for renovation projects of varying scopes and complexities through a prescriptive pathway for minor renovations and performance pathway for major renovation projects.

1. As in new construction, the renovation targets calculate the project energy and GHG budgets.
2. Renovations are considered “minor” or “major”. See section 3.7, 3.8 and 6.0.
3. All renovations shall target high performance energy and GHG performance designs.
4. Beyond energy, additional performance levels include:
   a. 50% reduction in indoor water use over the LEED™ version 4 baseline;
   b. 60% reduction in outdoor water use over the LEED™ version 4 baseline; and
   c. Complete whole-building air tightness testing following the US Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes and submit air leakage testing report.
5. The above targets are combined with project-specific information to establish unique energy and water efficiency targets for every building based on floor area and different space use types.
6. The project-specific goals are established as part of the Project Planning Report (PPR) or Project Initialization stage document, using the separately enclosed Project Charter.
7. The Project Charter outlines key project information, performance targets, and serves as a reference point throughout the project to ensure the performance goals are clearly understood by all involved parties and ultimately achieved.
1.16 Documentation Requirements and Timelines

1. To further ensure projects are developed in accordance with these performance requirements, documentation must be completed by the Project Consultant Team and/or the U of T Implementation Committee at each project stage. For each documentation item, the expectations and responsible parties are outlined in this Standard.

2. The documentation requirements for **New Construction projects and Renovations** are listed in Table 1.16.1 below:

### 1.16.1 New Construction: Documentation and Milestones

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<th>PPR</th>
<th>Project Initialization</th>
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3. Water efficiency worksheets apply when water use is required, e.g., kitchen addition or upgrades, washroom additions or upgrades, bottle refill stations, etc.

4. At each design milestone, these documents shall be prepared and reviewed by the Implementation Committee. These documents are to ensure designs are progressing in a way to meet the prepared performance targets and budgets.

5. The design process for renovations may or may not include a PPR Milestone. The scope, scale and targets may instead be defined at the Project Initialization milestone. U of T has an internal engineering and architectural team that may require outside consultants depending on the size and complexity of the renovation. If so, the RFP for these services will include the energy and GHG performance path based on targets prepared internally.

6. Not all renovations will require an energy performance model. When a comfort system is being modified or other renovation activity that affects energy use and a sizing exercise is required (e.g., Carrier HAP or equal), the energy performance report shall be prepared and presented at the SD stage (or equal) and updated at each of DD and CD stages.

7. The renovation may require reassigning the space as a different space than original (e.g., convert offices to labs). The design team shall target energy use indices for the new converted space to meet the new building targets unless otherwise approved by the Implementation Committee.

8. U of T Implementation Committee will prepare baseline energy and GHG performance indices based on existing building performance when there is an opportunity to impact the energy performance during a renovation. The design team shall target energy performance that is less than the existing energy use indices based on archetype classification on an area weighted average basis.
9. In all cases, renovations shall define the scope and scale of the project with energy and GHG performance taken into consideration, targeting high performance indices.

10. The documentation for Renovation projects and Renovations are listed in Table 1.16.2 below:

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2 ACRONYMS

- AHJ: Authority having Jurisdiction
- ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- CD: Construction documents project stage
- COP: Coefficient of Performance
- DD: Design development project stage
- F&S: Facilities and Services
- GHGI: Greenhouse Gas Emission Intensity
- GSM: Gross Square Meters
- HVAC: Heating Ventilation and Air Conditioning
- MFA: Modelled Floor Area
- NASM: Net Assignable Square Meters
- OBC: Ontario Building Code
- PPR: Project Planning Report
- SD: Schematic design project stage
- TEDI-Heating: Thermal Energy Demand Intensity for Heating
- TEDI-Cooling: Thermal Energy Demand Intensity for Cooling
- TEUI: Total Energy Use Intensity
- TGS: Toronto Green Standards, (Version 3 2019 or as amended)

3 DEFINITIONS

3.1 Archetypes

The building use types, archetypes, are based on dominant uses found on the campuses. The Implementation Committee will typically determine the archetype for each space at the PPR stage for use in the Charter. Current performance target guidelines do not include all the occupancy types that exist or are being built at U of T. The following archetypes were developed based on current and typical building type and occupancies. These are as follows;

3.1.1 Academic:

Classrooms, study areas (not associated with Libraries), lecture halls, common rooms, multipurpose rooms, related academic purpose spaces. Student density specific, plug loads are low-medium density, lighting at desk top reading levels, occupancy levels fluctuate from low to high through the business hours of a day. Typically less than 18/7, weekend scheduling, special event scheduling, vacation time shut downs.
3.1.2 Offices:

Staff, faculty, grad offices and related areas. Plug loads are medium, lighting at desk top at reading levels, occupancy is low, potential for occupancy control. Typically less than 18/7/365, weekend scheduling, vacation time shut downs.

3.1.3 Wet Labs:

High ventilation spaces (fume hoods, dedicated general exhaust), high plug and process loads, high lighting levels, and occupancy fluctuates through the day, possible 24/7/365 operation.

3.1.4 Dry Labs:

High plug and process loads, low to medium ventilation loads, lighting at desk for reading to high level for drafting, occupancy fluctuates through the day, typically less than 24/7/365, weekend scheduling, vacation time shut downs.

3.1.5 Retail:

Sales areas, dining/seating and common spaces (usually associated with food related services), non-industrial scale kitchens (NB: Consider Wet Lab for large kitchen areas with high ventilation), medium plug loads, high lighting levels, occupancy fluctuates, tending to peak periods. Typically less than 18/7/365.

3.1.6 Residential:

Living quarters, amenity and common spaces, lobbies. Low to medium plug loads, low lighting levels, occupancy fluctuates through the day 24/7/365, high DHW loads, potential for occupancy control.

3.1.7 Athletic:

Exercise rooms, gyms, change rooms, locker rooms, multipurpose rooms, pools, lobbies. Medium plug loads, medium to high light levels, medium ventilation loads, high DHW loads, occupancy fluctuates through the day, possible 24/7/365, weekend scheduling, vacation time shut downs.

3.1.8 Libraries & Other:

Stacks, common and reading rooms, lobbies, study carrels. Low plug loads, medium to high light levels, occupancy fluctuates from low to medium through the day, potential for occupancy control in stacks, study spaces, possible 24/7/365, weekend scheduling, vacation time shut downs. Includes spaces not described by
the archetypes above such as F&S storage, staff rooms, low energy shops (no heavy tools, excess ventilation).

3.2 **Targets and Budgets:**

Targets are energy and GHG annual maximum indices in equivalent units/m²/yr. These ratchet down every four (4) years. Budgets are calculated from the targets and GSM and define the maximum energy/GHG allowable budgets in equivalent units/year.

3.3 **Design Process Stage:**

Points at which the U of T Implementation Committee and Project Consultant Team design efforts require comprehensive modelling results and approvals. Note that “stage” and “milestone” are used interchangeably. A milestone usually referring to a deliverable action whereas a stage refers to a process.

3.4 **District Connected:**

A building that receives thermal energy (heating and/or cooling) from any of the U of T district energy systems. Buildings that receive some but not all thermal energy from a district energy system are considered district connected. The Charter requires that the district energy source be defined as from the steam plant (Steam District = Yes) or low temperature source such as recovered heat or heat pump (Steam District = No).

3.5 **Equivalent kW, ekWh:**

Equivalent kWh used to present different energy sources in a common unit based on accepted energy conversion factors from the Government of Canada. At site and includes delivery efficiencies. https://apps.cer-rec.gc.ca/Conversion/conversion-tables.aspx?GoCTemplateCulture=en-CA#1-7

3.6 **Greenhouse Gas Intensity (GHGI, kg eCO₂/m²/yr):**

(As defined in the TGS Energy Modelling Guidelines) The total greenhouse gas emissions associated with the use of all energy utilities on site on a per area basis, using the emissions factors in Section 7.12 of this standard.

\[
GHGI \left[ \frac{kg \text{ eCO}_2}{m^2 \text{year}} \right] = \frac{\sum \left( \frac{\text{Site Energy Use [ekWh]} \times \text{Emissions Factor [kg eCO}_2] \left[ \frac{ekWh}{eKW} \right]}{\text{Modelled Floor Area [m}^2]} \right)}{\text{Modelled Floor Area [m}^2]\right]
\]

3.7 **Major Renovation:**

Renovation projects that are anticipated to have a meaningful impact on the utility use of an existing building, which will be determined on a case-by-case basis by the U of T Implementation Committee.
Examples of major renovations could include cladding replacements or revitalization of the building, conversion of space use to a higher energy profile such as office to lab space.

3.8 Minor Renovation:

Renovation projects that are not anticipated to meaningfully impact the energy use of an existing building, as determined by the U of T Implementation Committee. Examples of minor renovations could include deferred maintenance replacement of HVAC, lighting upgrades, equipment or interior fit-out of tenant spaces.

3.9 Modelled Floor Area (MFA, m²):

(As defined in the TGS) The total enclosed floor area of the building, as reported by the energy simulation software, excluding exterior areas and parking areas. All other spaces, including semi-heated (as defined under SB-10 2017) and unconditioned spaces are included in the MFA. The MFA must be within 5% of the gross floor area from the architectural drawings, unless justification is provided demonstrating where the discrepancy arises and why the MFA should differ from the gross floor area by greater than 5%.

3.10 Multiplier:

The multiplier is a gross-up factor used to convert NASM to GSM in building planning. The Gross-up accounts for all non-assignable areas as well as building structure and internal and external wall assembly areas. The multiplier may differ between building space use types and is to be inputted by Campus and Facilities Planning in the PPR Form of the Charter.

3.11 New Construction Projects:

New building developments, including new additions to existing buildings, are considered new construction projects under this standard. Projects that require a Site Plan Approval are considered “New”.

3.12 Non-District Connected:

A building that generates all of its thermal energy on site and does not receive thermal energy from any of the U of T district energy systems. Hybrid buildings (e.g., a building served by district heating and on site cooling equipment) are considered District Connected when calculating performance targets using the Project Charter.

3.13 Occupancy:

Calendar year when occupancy is scheduled to occur. Defines the targets in the Charter through the “Proposed Occupancy Date” cell.
3.14 Ontario Building Code (OBC):

The current Ontario Building Code at the time of the Project Implementation, as amended and required for building permit submission. Project Consultant and Implementation to take into consideration future upgrades for project occupancy beyond 2021.

3.15 Project Charter:

The Project Charter is a separately enclosed worksheet-style Excel document that outlines project-specific performance budgets/targets. The Charter establishes the required performance levels for each project and serves as a reference point during the design process. Prepared and presented with the PPR for architect and/or design team selection.

3.16 Project Consultant Team:

Typically consisting of: architectural, energy modelling, mechanical, electrical, plumbing consultants, etc., selected to complete the project. In the case of renovations, the Team may include internal engineering staff. U of T reserves the right to accept or reject any of the proposed consultants. The consultants carried in the RFP shall not be altered post-RFP submission without written acceptance by U of T.

3.17 Project Planning Report (PPR):

Specifies all desired building space program, functional requirements and/or special facilities consistent with the academic priorities and requirements. PPRs are prepared by U of T for all individual capital projects and Infrastructure Renewal Projects for which Project Committees are established.

3.18 Site Energy Use:

All energy used on site including all end-uses (e.g., heating, cooling, fans, pumps, elevators, parkade lighting and fans, and exterior lighting, etc.). It incorporates all site efficiencies, including the use of heat pumps or re-use of waste heat. Site Energy Use can be reduced using Site Renewable Energy Generation by applying the energy generation as a credit to the utility that is being avoided (e.g., electricity, natural gas, district energy). For design alternatives that include district energy connections, central utility plants, and/or thermal energy obtained from neighboring facilities, the generation energy (inclusive of thermal efficiency and associated losses) will be included as part of the Site Energy Use.

3.19 Site Renewable Energy Generation:

Energy generated on site from renewable sources, such as solar photovoltaics (PV), wind, or solar thermal. Where a site is not able to send energy off-site (e.g. connected to the electricity grid), only energy that can be consumed (or stored and then ultimately consumed) on site shall be counted as Site Renewable Energy Generation. Site Renewable Energy Generation can be used to reduce Site Energy Use before calculating TEUI and GHGI. The U of T is not considering the purchase of renewable energy or other carbon offset packages.
3.20 **Total Energy Use Intensity (TEUI, ekWh/m²/year):**

(As defined in the TGSv3 Energy Modelling Guidelines). The sum of all energy used on site (i.e., electricity, natural gas, and district heating and cooling), minus any Site Renewable Energy Generation, and divided by the Modelled Floor Area.

\[
TEUI \left[ \frac{ekWh}{m^2 \text{year}} \right] = \frac{\text{Site Energy Use} \left[ \frac{ekWh}{\text{year}} \right]}{\text{Modelled Floor Area} \left[ m^2 \right]}
\]

3.21 **Thermal Energy Demand Intensity for Heating (TEDI-Heating, kWh/m²/year):**

(As defined in the TGSv3 Energy Modelling Guidelines). The annual heating delivered to the building for space conditioning and conditioning of ventilation air. Measured with modelling software, this is the amount of heating energy delivered to the project that is outputted from any and all types of heating equipment, per unit of Modelled Floor Area. Heating equipment includes electric, gas, hot water, or direct expansion (DX) heating coils of central air systems (e.g., make-up air units, air handling units, etc.), terminal equipment (e.g., baseboards, fan coils, heat pumps, reheat coils, etc.) or any other equipment used for the purposes of space conditioning and ventilation. Heating output of any heating equipment where the source of heat is not directly provided by a utility (i.e., electricity, gas, or district energy) must still be counted towards the TEDI-heating. For example, hot water or heat pump heating sources that are derived from a waste heat source or a renewable energy source do not contribute to a reduction in TEDI-heating, as per the above definition. Specific examples of heating energy that are not for space conditioning and ventilation, which would not be included in the TEDI include: maintaining swimming pool water temperatures, outdoor comfort heating (e.g. patio heaters, exterior fireplaces), gas-fired appliances (e.g. stoves, dryers), heat tracing, etc.

\[
TEDI\text{-heating} \left[ \frac{kWh}{m^2 \text{year}} \right] = \frac{\sum \text{Space and Ventilation Heating Output} \left[ \frac{kWh}{m^2 \text{year}} \right]}{\text{Modelled Floor Area} \left[ m^2 \right]}
\]

3.22 **Thermal Energy Demand Intensity for Cooling (TEDI-Cooling, kWh/m²/year):**

The annual cooling delivered to the building for space conditioning and conditioning of ventilation air. Measured with modelling software, this is the amount of cooling energy delivered to the project that is outputted from any and all types of cooling equipment, per unit of Modelled Floor Area. Cooling equipment includes chilled water or DX coils of central air systems (e.g., make-up air units, air handling units, etc.), terminal equipment (e.g., fan coils, heat pumps, chilled beams, etc.) or any other equipment used for the purposes of space conditioning and ventilation. Cooling output of any cooling equipment whose heat rejection is not directly provided by a utility (i.e., electricity, gas, or district) must still be counted towards the TEDI-cooling. For example, chilled water or heat pump cooling sources that are derived from a waste heat rejection source do not contribute to a reduction in TEDI, as per the above definition.
3.23 **Toronto Green Standard (TGS v3 in effect as of January, 2020):**


3.24 **U of T Implementation Committee:**

A project group made up of U of T staff and/or assigned personnel as required for the project with authority to develop and implement the project. The project manager assigned to the project by U of T shall be the main point of contact. The Implementation Committee must include a representative from Facilities & Services.

3.25 **Ventilation loads:**

Delivery of and removal of air is treated in different ways by the range of Standards and Guidelines. Ventilation is to be modelled as per design. Recognizing the impact ventilation has on the energy and GHG loads, the U of T requires that ventilation loads be broken out, when included in the models, and presented as indices on its own, ekWh/m$^2$ in order to assess the impact on the TEDI targets. The intention is to ensure the TEDI is representative of a superior envelope design without being lost in a high ventilation load such as large kitchens and laboratories. The ventilation index shall be prepared and presented separately for review and consideration by the Implementation Committee.
4 INTRODUCTION

4.1 Motivation and Intention

The University of Toronto (U of T) has committed to reducing its scope 1 and 2 GHG emissions across all three campuses to 37% below its 1990 level by 2030. This represents a reduction from 116,959 tonnes eCO2/year in 1990 to 73,684 tonnes eCO2/year by 2030 – eliminating 43,275 tonnes eCO2/year across the University’s portfolio – not including population and new building growth. This plan puts the university on the path to becoming a net-zero GHG institution by 2050. Achieving this goal calls for substantial reductions in energy consumption and resultant GHG emissions for both new construction, renovation projects and existing buildings. Accordingly, U of T has replaced the previously governing Energy Performance & Modelling Standard (April 1, 2019) with this new Tri-Campus Energy Modelling & Utility Performances Standard (July 1, 2020).

Energy and GHG reductions are more than cutting costs. U of T strives to provide high performance facilities as part of the core mission to provide world class research and higher education for its students, faculty and staff. These standards were developed to,

1. Target low carbon performance to achieve the 2030 goals and path to zero carbon 2050,
2. Anticipate and increase resiliency against future climate based changes,
3. Encourage long term high performance designs,
4. Reduce the performance gap between predicted energy/carbon performance and actual,
5. Engage planning and engineering staff with design teams,
6. Encourage the sound use of innovative designs and technologies,
7. Increase communication amongst stakeholders,
8. Right timing for optimum renovation impact,
9. Standardize the modelling inputs and compliance process and,
10. Increasing the recognition of the University as leaders in the transition to a low carbon, high performance organization.

This standard focuses on the energy modelling process that Project Consultant Teams must follow, in addition to the required levels of performance related to utilities (i.e., energy and water consumption) that all new construction and renovation projects must achieve. The performance targets have been formalized into this standard and a separately enclosed Project Charter to balance environmental stewardship with design efficacy.

Project Consultant Teams must meet the performance targets indicated in this standard and Charter and are encouraged to use creative and contextually-specific solutions based on the unique project characteristics of the design at hand.

The energy, comfort and carbon performance of the building, new or renovation, will vary. These Standards assist the design teams to be able to compare to other buildings with defined limits leading to a better prediction of performance after occupancy as well as on-going benchmark analyses.

These Standards are not meant to predict actual performance due to the range of variables – intensity, occupancy hours, occupancy behaviour, weather, as-built versus as-designed. The intention is to encourage
integration between the design teams and the University with a common goal of consistent, measurable high performance facilities.

4.2 Applicable Projects

U of T’s ambitious GHG emission reduction target will require action and attention to optimizing the utility performance of all new and existing buildings. As such, this standard applies to all building projects on all three campuses of U of T. Wherever possible, this standard is intended to be performance-based, giving Project Consultant Teams the flexibility to implement creative, contextually appropriate solutions to meet the performance requirements outlined in this standard and the Project Charter.

New construction projects, including any new development or major addition(s) to an existing building, are expected to reach the performance thresholds outlined in Utility Performance Requirements for New Construction Projects.

Acknowledging the variety in scale of renovation initiatives, different requirements have been developed for “minor renovations” and “major renovations”. Projects must meet the corresponding performance requirements outlined in the Utility Performance Requirements for Minor Renovation Projects and Utility Performance Requirements for Major Renovation Projects.

There are many nuances to the definitions of new construction, major and minor renovation. For this reason, the above is provided as a general guide, and projects will be categorized on an individual basis at the discretion of the U of T Implementation Committee. Baseline energy use will be determined by the U of T Implementation Committee.

4.3 Background on Standards Development

The performance metrics included in this standard were developed through an archetypal energy modelling process and a review of the current landscape of sustainability requirements in industry standards and guidelines, and in the sustainability standards of other leading post-secondary institutions.

A review of existing sustainability standards and guidelines was conducted to gather the performance metrics associated with energy and water efficiency. From this review, the leading performance metrics were selected for adoption into this standard, with the goal of including energy and water requirements that will help guide U of T towards achievement of their GHG emission reduction goals. These utility requirements have been formalized into this performance-based standard and the separately enclosed Project Charter.

The energy performance targets were developed using an energy modelling exercise that involved creating six archetype energy models based on the geometries and functional programming of representative U of T buildings (two additional are based on these basic six archetypes for a total of eight archetypes in the Tables).

These archetype energy models were iterated to explore the improvements in energy performance that could be achieved using technologies and systems that are available in the current market. Additionally, the opportunities for energy and GHG emission reduction in district-connected buildings were considered
separately from the opportunities in buildings with on-site thermal plant equipment. The archetype energy models are considered a proof of concept for the energy performance targets in this standard.
5 NEW CONSTRUCTION PROJECTS

5.1 Utility Performance Requirements for New Construction Projects

5.1.1 Energy

New construction projects must meet the project-specific energy performance targets and budgets established in the Project Charter. The requirements will be calculated using the archetype targets in tables 5.1.1, 5.1.2, and 5.1.3 and project information, including: planned building use, year of occupancy, presence of a connection to the U of T district steam or low temperature heating, and district chilled water energy systems. For buildings with mixed uses, the targets are area-weighted using the Project Charter to determine a set of performance targets that are representative of the building programming.

The Project Consultant Team must complete and submit an energy simulation, key performance indicators (TEUI, TEDI, GHGI) with associated documentation at each stage of the design process to demonstrate ongoing compliance with these performance targets.

At the completion of the commissioning, the simulation must be updated to reflect the as-constructed building characteristics. This will form the basis of the baseline performance.

5.1.1 New Construction: Targets for Scheduled occupancy dates between 2020 to 2022

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Thermal energy Source</th>
<th>TEUI</th>
<th>GHGI</th>
<th>TEDI - Heating</th>
<th>TEDI - Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ekWh/m²/yr</td>
<td>kg CO₂/m²/yr</td>
<td>ekWh/m²/yr</td>
<td>ekWh/m²/yr</td>
</tr>
<tr>
<td>Academic</td>
<td>District Energy</td>
<td>105</td>
<td>16</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>80</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>District Energy</td>
<td>105</td>
<td>16</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>80</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Labs</td>
<td>District Energy</td>
<td>510</td>
<td>50</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>430</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Labs</td>
<td>District Energy</td>
<td>230</td>
<td>16</td>
<td>20</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>210</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>District Energy</td>
<td>130</td>
<td>16</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>105</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td>District Energy</td>
<td>105</td>
<td>11</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>80</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athletic</td>
<td>District Energy</td>
<td>112</td>
<td>16</td>
<td>40</td>
<td>35</td>
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<tr>
<td></td>
<td>Non-District</td>
<td>85</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td>District Energy</td>
<td>100</td>
<td>15</td>
<td>38</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>75</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.1.2 Future Targets (2022 – 2030)

The targets will be revisited and adjusted regularly to ensure U of T remains in a leadership position. The progression of targets depends on numerous factors, many of which are outside U of T’s direct control (e.g., the rate at which new technologies come to market). However, projects should anticipate the following adjustments for 2022-2026 (Table 5.1.2) and 2026-2030 (Table 5.1.3) for all the key performance indicators included in the standard.

5.1.2 New Construction: Targets for Scheduled occupancy dates between 2022 to 2026

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Thermal energy Source</th>
<th>TEUI</th>
<th>GHGI</th>
<th>TEDI - Heating</th>
<th>TEDI - Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ekWh/m²/yr</td>
<td>kg eCO₂/m²/yr</td>
<td>ekWh/m²/yr</td>
<td>ekWh/m²/yr</td>
</tr>
<tr>
<td>Academic</td>
<td>District Energy</td>
<td>97</td>
<td>15</td>
<td>37</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>75</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>District Energy</td>
<td>97</td>
<td>15</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>75</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Labs</td>
<td>District Energy</td>
<td>470</td>
<td>46</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>395</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Labs</td>
<td>District Energy</td>
<td>212</td>
<td>15</td>
<td>20</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>195</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>District Energy</td>
<td>120</td>
<td>15</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>195</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td>District Energy</td>
<td>97</td>
<td>10</td>
<td>28</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>74</td>
<td>5</td>
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<tr>
<td>Athletic</td>
<td>District Energy</td>
<td>103</td>
<td>15</td>
<td>38</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>78</td>
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<tr>
<td>Library</td>
<td>District Energy</td>
<td>92</td>
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<td></td>
<td>Non-District</td>
<td>69</td>
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</table>

The targets and resulting budgets in during scheduled occupancy between 2022 - 2026 are approximately 10% less than those in the Table 5.1.1. This assumes technologies, designs and construction capabilities will have improved in keeping with industry best practices to achieve high performance buildings.
5.1.3 New Construction: Targets for Scheduled occupancy dates between 2026 to 2030

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Thermal energy Source</th>
<th>TEUI (ekWh/m²/yr)</th>
<th>GHGI (kg eCO₂/m²/yr)</th>
<th>TEDI - Heating (ekWh/m²/yr)</th>
<th>TEDI - Cooling (ekWh/m²/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>District Energy</td>
<td>78</td>
<td>12</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>59</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>District Energy</td>
<td>78</td>
<td>12</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>59</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Labs</td>
<td>District Energy</td>
<td>376</td>
<td>37</td>
<td>76</td>
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<tr>
<td></td>
<td>Non-District</td>
<td>316</td>
<td>22</td>
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<tr>
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<td>District Energy</td>
<td>170</td>
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<td>Retail</td>
<td>District Energy</td>
<td>96</td>
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<td>19</td>
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<tr>
<td></td>
<td>Non-District</td>
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<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td>District Energy</td>
<td>78</td>
<td>8</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
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<tr>
<td></td>
<td>Non-District</td>
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<td></td>
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<tr>
<td>Library</td>
<td>District Energy</td>
<td>75</td>
<td>10</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Non-District</td>
<td>57</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The targets and resulting budgets assigned to scheduled occupancy between 2026 and 2030 are approximately 20% lower than those in Table 5.1.2 to account for increased capabilities of designers, technologies and the industry practices to meet net zero targets by 2030 in many jurisdictions, including the City of Toronto.

5.1.4 Air Leakage

Uncontrolled air in/ex-filtration is a significant and unpredictable energy load for the life of the building. The University shall require the envelope and air barrier provide a high performance reliable, continuous and durable air barrier for all designs.

All new buildings and whole building renovations must undergo air leakage testing following the U.S. Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes, version 3 (May 11, 2012). The final air leakage testing results and report must be submitted to the U of T Implementation Committee, and the result used in the final occupancy energy model. See the U of T Utilities & Building Operations Commissioning Process for Overall Building Commissioning (refer to the Reference section for a link).

There is no maximum required whole-building air leakage rate for new construction projects; however, a target whole building air leakage rate must be presented and accepted by the U of T Implementation Committee at/during the Project Initialization before use in all design phase energy modelling.

Assumptions used by the energy modelling team as regards to air leakage shall be presented to the Project Consultants and Implementation Committee for description, consideration and review before being used in
the model. If a reduced infiltration rate is suggested, the project must commit to achieving the air tightness target and confirmed by mandatory air tightness testing.

Air leakage testing shall be completed by a third party, not associated with the Project Consulting Team proficient in these tests and the report(s) presented to the U of T Implementation Committee.

The results from any air leakage testing shall be made available to the energy modelling team as soon as possible to refine the air leakage factor inputs to complete the final model report.

5.1.5 Water

To further reduce GHG emissions, indoor and outdoor water consumption performance targets have been set in accordance with the higher levels of performance in LEED™ version 4 as follows:

- A minimum indoor water use reduction of 50% below the LEED™ version 4 baseline consumption; and
- A minimum outdoor water use reduction of 60% below the LEED™ version 4 baseline consumption.

The Project Consultant Team must submit a completed LEED™ v4 indoor water use reduction calculator and an outdoor water use reduction calculator to demonstrate the design fixture flush and flow rates will meet the required indoor and outdoor water use reductions. The current excel based LEED™ v4 calculators can be found online on the LEED™ New Construction website (refer to the Reference section for a direct link).

5.1.6 LEED™

The University requires that all new buildings and major renovations shadow LEED™ Silver compliance as a minimum. The Project Consultant shall prepare a LEED™ Scorecard illustrating that if the project were to pursue certification it would collect sufficient points to meet LEED™ Silver (50-59 points).

Maximizing points in the Energy & Atmosphere, Sustainable Sites, Water Efficiency, Indoor Environment, and Enhanced Commissioning shall be pursued.

The Project Planning Report and/or Project Initialization step will define if LEED™ certification is to be pursued.

5.1.7 Other Considerations

New construction will increasingly include multiple uses and occupancies resulting in “mixed use buildings”. As indicated, the energy performance targets and resulting budgets will be based on the area weighted aggregate as calculated by the Charter. Care is required when assigning the use areas when completing the Charter. For example, a large commercial kitchen would best be assigned as a wet or dry
lab depending on and to account for the high ventilation loads, a math lab might be closer to an office space as it likely only includes medium plug loads and lighting but not high ventilation.

Heat or energy recovery ventilators shall be modelled according to design even when the modelling software has limited capacity to predict energy performance. Sensible recovery efficiency is to be used to define the energy performance. If work-arounds are required, the Project Consultant shall describe the procedures used and the effect on energy calculations.

Thermal bridging shall be taken into consideration when the over-all thermal U-value of wall assemblies are defined. For energy modelling.

District Energy includes that energy supplied from a central steam or other gas fired network. For networks supplied from low temperature heating sources (heat pumps, heat reclaim energy) the non-district system targets and factors will be used. See Section 7.10 and 7.11 for efficiencies and factors for these system applications.

5.2 Documentation Requirements for New Construction Projects

To ensure projects are developing in accordance with the utility performance requirements, documentation must be completed by the Project Consultant Team and/or the U of T Implementation Committee at each project milestone, table 5.2.1, below, summarizes the documentation that must be submitted at each milestone of a new construction project. For each documentation item, the expectations and responsible parties are outlined in sections that follow.

**PPR: Project Planning Report.** This document, prepared by U of T staff, contains the basic description of the project including program uses, planned NASMs, and anticipated occupancy date. This document is used to develop the scope of work for the design teams and is included in any request for proposals. It will include the energy Charter.

**Project Initialization:** The design team(s) and/or Project Consultant Team and U of T Implementation Committee have been established. At this point the energy performance criteria have been defined. In the case of renovations, the scope of work and target energy performance criteria have been defined and communicated to the teams. When available, existing energy/GHG use indices will be used to define the baselines for renovation projects.

**SD:** Schematic design. Typically considered a design at ~30% and includes sufficient detail for the modeling team to define the preliminary energy and GHG performance. This will give the Implementation Committee and Project Consultant sufficient indication of the energy performance direction and if designs require tuning in order to meet the defined targets.

**DD:** Detailed design. Typically considered a design at ~60% complete with major design elements defined. Energy modelling at this milestone will be based on refinements at the SD stage. At this milestone, major modifications to energy performance inputs should be confined to operational refinement; hours of operation and all envelope and energy systems design details are expected to be defined.

**CD:** Construction design. Considered construction ready documents. Minor modifications may occur at this milestone that should not significantly impact the design or performance of energy systems. The final model at this point is used as the baseline energy performance for post-occupancy evaluation.
Occupancy: The building has been commissioned and program use can begin. Any changes that are noted during the commissioning must be included in to the model and a revised model completed as the adjusted baseline. A post-occupancy energy performance evaluation will be completed by U of T facilities & Services staff. The energy and GHG performance indices will be compared to that delivered at the CD stage. If the actual energy performance exceeds the predicted performance by more than 15%, the design team/modelers will be asked to comment and assist U of T to determine the possible reasons for the variation.

5.2.1 New Construction: Documentation Submission Requirements by Project Milestone

<table>
<thead>
<tr>
<th>Documentation</th>
<th>PPR</th>
<th>Project Initialization</th>
<th>SD</th>
<th>DD</th>
<th>CD</th>
<th>Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Charter – PPR Form</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Charter – Design Form</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Charter – Project Submissions Checklist</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
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<tr>
<td>Energy Simulation Files</td>
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<td></td>
<td></td>
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<tr>
<td>Energy Performance Report</td>
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<tr>
<td>Water Efficiency Worksheets</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary of Changes from Previous Submission</td>
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<td>●</td>
<td>●</td>
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<tr>
<td>Equipment Cut Sheets</td>
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<tr>
<td>Air Leakage Test Report</td>
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<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>

At multiple milestones in the design process, the Project Consultant Team will also be required to submit documents to the municipal Authority Having Jurisdiction. The municipal document submission requirements for Toronto and Mississauga align with the U of T project milestones as shown in Table 5.2.2:

5.2.2 Regulatory Submissions vs U of T Project Milestones

<table>
<thead>
<tr>
<th>Regulatory Submission</th>
<th>U of T Project Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoning Bylaw Amendment / Official Plan</td>
<td>SD</td>
</tr>
<tr>
<td>Amendment (if required)</td>
<td></td>
</tr>
<tr>
<td>Site Plan Control Application</td>
<td>DD</td>
</tr>
<tr>
<td>Building Permit</td>
<td>CD</td>
</tr>
<tr>
<td>Occupancy Permit</td>
<td>Occupancy</td>
</tr>
</tbody>
</table>

5.2.3 Project Charter

The Project Charter is a calculation tool to define the project-specific performance targets and resulting budgets and provide a central repository for the assumptions and design characteristics that drive the utility performance of buildings.

It is comprised of three parts: the PPR Form; the Design Form; and the Project Submissions Checklist. The Project Charter serves as a reference point throughout the design process to ensure the performance goals.
are clearly understood by all involved parties and ultimately achieved. It is typically prepared by staff within University Planning, Facilities & Services and Property Management Design & Construction.

The Charter is defined no later than the start of Project Initialization and intended to inform the design teams of energy and GHG budgets for their understanding during the tender and selection process.

### 5.2.4 Project Planning Report (PPR) Form

The PPR Form of the Project Charter will be completed by the U of T Implementation Committee and provided to the Project Consultant Team. This will typically be included with the design team request for proposal for new and major renovations.

The PPR Form calculates project-specific performance targets based on attributes known at the PPR milestone, such as floor area and space use type. The PPR Form will be completed by Campus and Facilities Planning in consultation with Facilities and Services.

The equivalent for a minor renovation is a project scope description and typically prepared and presented at the Project Initialization stage.

The final PPR Form must be reviewed and approved by Facilities and Services (F&S) representatives listed in Table 5.2.5:

<table>
<thead>
<tr>
<th>Campus</th>
<th>F&amp;S Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>St George</td>
<td>Paul Leitch, Director of Sustainability, St. George</td>
</tr>
<tr>
<td>Scarborough</td>
<td>Jeffrey Miller, Director of Facilities &amp; Services, UTSC</td>
</tr>
<tr>
<td>Mississauga</td>
<td>Ahmed Azhari, Director, Utilities &amp; Sustainability, UTM</td>
</tr>
</tbody>
</table>

### 5.2.5 F&S Representatives for PPR Form Review

<table>
<thead>
<tr>
<th>Campus</th>
<th>F&amp;S Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>St George</td>
<td>Paul Leitch, Director of Sustainability, St. George</td>
</tr>
<tr>
<td>Scarborough</td>
<td>Jeffrey Miller, Director of Facilities &amp; Services, UTSC</td>
</tr>
<tr>
<td>Mississauga</td>
<td>Ahmed Azhari, Director, Utilities &amp; Sustainability, UTM</td>
</tr>
</tbody>
</table>

### 5.2.6 Design Form

The Design Form of the Project Charter will be completed by the Project Consultant Team and reviewed and approved by the U of T Implementation Committee and F&S Representative.

The Design Form is used to confirm the utility performance targets that were established on the PPR Form and record the project characteristics that are drivers of utility performance. The Project Consultant Team must confirm the energy modelling software, weather file, and target whole building air leakage rate that will be used for the project.

In addition to the completion of the Design Form, the Project Consultant Team shall outline the intended energy modelling approach and reporting format, for approval by the U of T Implementation Committee.
5.2.7 Project Submissions Checklist

The Project Submissions Checklist included in the Charter summarizes the documentation requirements and creates a centralized summary of the utility performance metrics at each submission. The Project Consultant Team must complete and submit the checklist at each project milestone.

5.2.8 Energy Simulation Files

The Project Consultant Team must submit all model simulation files (input, output, weather files, and any external calculations) to demonstrate that the proposed design will achieve the required performance budgets as defined in the Project Charter.

All simulation data files and output formats must be accepted by the Implementation Committee before any subsequent design stages are initiated. A

The modelling team shall be prepared to implement any changes discovered during the commissioning that impact the energy performance and must be included into the energy model and the model updated to reflect actual as-built conditions and installed equipment.

When an energy simulation is used for any renovations (e.g., to size a new HVAC system) the results of the sizing exercise shall be presented to the Implementation Committee. Energy use indices shall be compared to existing building energy baseline indices, prepared and presented by the Implementation Committee.

5.2.9 Energy Performance Reports

The Project Consultant Team must submit an Energy Performance Report that includes the following:

- Reports are to be submitted at each design milestone;
- Summary of key energy model inputs, including any specific operational measures assumed or used that will impact the performance indices;
- Performance results for four key metrics (TEUI, GHGI, TEDI-Heating, and TEDI-Cooling);
- Ventilation loads presented as ekWh/m² to assess the impact on the TEDI budget;
- Building energy use broken down by end-uses and fuel type;
- Calculated whole-enclosure effective thermal performance (i.e. the area-weighted U-value) following the methodology outlined in TGS v3;
- Graph of annual hourly thermal demand with a table to report the peak heating and cooling demand (kW) and annual heating and cooling demand (kWh);
- Narrative and analysis describing the thermal autonomy of the building (i.e., the fraction of time that a building can maintain an acceptable indoor condition, despite the failure of active building systems);
- Description of air leakage control measures, including the modelled air leakage rate and all plans, measures, and protocols being implemented to improve enclosure air tightness;
- Design details and calculations for any on-site renewable energy generation;
- Explanation of any externally calculated energy performance; modelling software limitations;
• Any additional information that is provided as part of the project’s submission to the Authority Having Jurisdiction;
• If LEED™ is not being pursued, illustrate how many points would be eligible for LEED™ Silver in the Energy and Atmosphere category.

5.2.10 Water Efficiency Worksheets

The Project Consultant Team must submit a completed LEED™ v4 indoor water use reduction calculator and an outdoor water use reduction calculator to demonstrate the design fixture flush and flow rates will meet the required indoor and outdoor water use reductions.

The current excel based LEED™ v4 calculators can be found online on the New Construction website (refer to the Reference section for a direct link).

5.2.11 Summary of Changes

For submissions that update previously submitted documentation, the Project Consultant Team must provide a summary narrative that clearly outlines any changes at any project design stage.

5.2.12 Equipment Cut Sheets

Cut sheets and documentation of the proposed and modelled equipment shall be presented to the U of T Implementation Committee during the Schematic Design stage to verify proposed energy performance opportunities.

Any changes to the proposed equipment must be approved by the U of T Implementation Committee.

5.2.13 Air Leakage Test Report

The project team may be required to complete an air leakage test during the construction. The energy modelling team shall be prepared to update the energy modelling based on actual air leakage testing results.

The air leakage tests, when specified, will be used to refine the air leakage factors in the energy modelling process. Per the U of T Commissioning Process, the Project Consultant Team must conduct whole-building air leakage testing. An air leakage testing report must be submitted to the U of T Implementation Committee using the reporting template found in Appendix A of the U.S. Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes, version 3 (May 11, 2012), and the tested air infiltration rate must be used in the energy model at Occupancy stage.

A third party group, not in any way associated with the Project Consultant Team and expert in air leakage testing must be used. The results shall be made available to the energy modelling team as soon as they are
available. The energy modelling team shall use the actual air leakage test results for inputs to the energy performance model.
6 RENOVATION PROJECTS

6.1 Scale of Renovation Projects

The renovation of existing buildings plays a critical part in U of T’s plan to achieve the established 2030 GHG emission reduction target.

As such, all renovation projects at U of T are expected to strive towards high performance energy, GHG, water efficiency and sustainability; however, the opportunity for GHG emission reduction varies as projects range in scope.

To accommodate this, the Standard has different requirements for minor and major renovations. Examples of minor renovation projects include but are not limited to: deferred maintenance, lighting or BAS upgrades or tenant fit-out. Major renovation projects include but are not limited to: space use conversion, whole-building revitalization, new windows or cladding replacement.

Each project will be designated Minor Renovation or Major Renovation by the U of T Implementation Committee, as approved by the F&S Representative listed in Table 6.1.1 below.

<table>
<thead>
<tr>
<th>F&amp;S Representatives for Renovation Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Campus</strong></td>
</tr>
<tr>
<td>St George</td>
</tr>
<tr>
<td>Scarborough</td>
</tr>
<tr>
<td>Mississauga</td>
</tr>
</tbody>
</table>

6.2 Utility Performance Requirements for Minor Renovation Projects

The utility performance requirements for minor renovation projects form a prescriptive list, intended to accommodate a wide variety of project scopes.

Projects within this category are typically completed by Property Management, Facilities & Services. Typically Minor Renovations do not require an energy load calculation, e.g., lighting retrofits, low-flow water fixtures, high efficiency appliances, classroom furniture, thermostat refit.

Minor renovations are directed in cooperation with the internal engineering department. The scope will be defined at the Project Initialization step. Whenever the scope includes measures that impact energy use, high performance, low energy/GHG designs shall be pursued.

Alterations that include some HVAC modifications can border on major renovations. If an energy load calculation is required, energy targets presented here shall be included in the project scope. A baseline shall be defined using existing energy use indices where available for target comparison.

When the project scope has been defined to the Project Management team, the project consultants shall meet with Facilities & Services to determine the project as major or minor. See Tables 6.3.2, 6.3.3 and 6.3.4 for energy reduction targets for minor and major renovations.
6.2.1 Energy

Where applicable (e.g., there will be an impact on energy use), all minor renovation projects must meet the mandatory and prescriptive provisions of SB-10 Division 3 Chapter 2 “Additional Requirements to 2013 ANSI/ASHRAE/IES 90.1” for all improvements. In addition, projects must comply with all applicable requirements as follows:

- Provide a separate control zone for each solar exposure and interior space. Provide controls capable of sensing space conditions and modulating the HVAC system in response to space demand for all private offices and other enclosed spaces (e.g. conference rooms, classrooms). Refer to the LEED version 4 Reference Guide for Interior Design and Construction for more information (refer to the Reference section for a link).
- Reduce the connected interior lighting power density by 25% below that allowed by SB-10 Division 3 Chapter 2 as calculated using the space-by-space method.
- Install daylight-responsive controls in all regularly occupied daylit spaces within 4.5 m (15 ft) of windows and under skylights for at least 25% of the connected lighting load. Daylight controls must switch or dim electric lights in response to daylight illumination in the space.
- Design exterior lighting to meet Dark Sky criteria.
- Install occupancy sensors for at least 75% of connected lighting load.
- Install Energy Star appliances, office equipment, electronics, and commercial food service equipment for 100% of equipment and appliances.
- Comply with the requirements of SB-10 Division 3 Chapter 2 for the performance of all exterior building envelope components impacted by the renovation project.
- Comply with the requirements of SB-10 Division 3 Chapter 2 for the performance of all HVAC components impacted by the renovation project.
- When enhanced or improved controls are installed, energy conservation sequences including but not limited to time of day scheduling, night setback/day setup, and occupancy setpoints shall be included.

6.2.2 Water

Where minor renovation projects involve changes to water-consuming fixtures, water consumption must be reduced as follows:

- Indoor water use must be reduced by 50% below the LEED™ version 4 baseline consumption.
- Outdoor water use must be reduced by 60% below the LEED™ version 4 baseline consumption.

The project team must submit a completed LEED™ v4 indoor water use reduction calculator and an outdoor water use reduction calculator to demonstrate the design fixture flush and flow rates will meet the required indoor and outdoor water use reductions.

The current excel based LEED™ v4 calculators can be found online on the LEED™ New Construction website (refer to the Reference section for a direct link).
LEED™ ID+C may be considered for renovation projects (minor and major) and also shadow LEED™ Silver minimum. U of T recognizes LEED™ may not always be applicable for minor renovations and assess on a project by project basis and announced to within the issue of any design or project implementation tender documents. If any renovation project requires an energy load model, LEED™ prescriptive compliance shall be considered. In all cases, the design team shall review the project scope in terms of LEED™ compliance by Project Initialization.

6.3 Utility Performance Requirements for Major Renovation Projects

The utility performance requirements for major renovation projects are intended to provide a performance-driven approach, rather than prescriptive, while accommodating a wide variety of project scopes, goals, and limitations.

Major renovations typically require a request for tender process with scope of work included to select an outside architect/engineering companies.

Project-specific energy and water reduction targets will be developed for each major renovation project based on renovation area and building use type and included in the project request for proposal.

This information will be recorded in the Project Charter. A major renovation can be comprised of multiple space use categories, and this is accounted for in the Project Charter using an area-weight approach.

6.3.1 Energy

To accommodate variety in the scope of major renovation projects, including building-specific constraints (e.g. heritage buildings) the components of major renovation projects have been categorized as follows:

1. Interior System Renovations: upgrades to the interior portions of the building (e.g., lighting upgrade);
2. Mechanical System Renovations: upgrades to the mechanical systems serving the building (e.g., heating system upgrade); and
3. Envelope Renovations: upgrades to the building envelope (e.g., window upgrade).
4. Space use conversion (e.g., from office to lab space)

Projects will be characterized into one or multiple of these categories when determining the performance requirements.

If the project will impact multiple building components, it will be held to the performance level of the most relevant renovation category, or the sum of multiple categories. For example, if an existing building is upgrading its interior and envelope systems, it will be required to meet the combined Interior and Envelope targets.

The category assignment will be done by the U of T Implementation Committee on a project-specific basis.
In addition, the renovation project areas will be assigned to an appropriate building type or mix of types. These building types follow the archetype building types used in New Construction targets.

The categorization and building type will be input to the Project Charter to calculate an energy use reduction that the project must achieve, using the per cent reductions listed in Error! Reference source not found. 3.2, 6.3.3 and 6.3.4 depending on when the project is scheduled for occupancy. For buildings with mixed uses, the targets will be area-weighted using the Project Charter to determine a performance target that is representative of the building programming.

All renovation Targets are minimum requirements and relative to the baseline year energy performance calculated using actual utility data from the 12 months (min) prior to the project design start. If actual utility data is not available, an estimated energy use index can be calculated using a building from the same benchmark category or the TEUI targets in Table 5.1.1 “New Construction Targets for occupancy between 2020 to 2022”.

The total project GSM area will be the sum of prorated areas and indices according to the use type found in Table 5.1.1.

Major renovation energy reduction targets are shown in Table 6.3.2;

### 6.3.2 Major Renovation: Targets for Scheduled Occupancy between 2020 to 2022

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Interior Renovations: Target % Reduction</th>
<th>Mechanical Renovations: Target % Reduction</th>
<th>Envelope Renovations: Target % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>6%</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Offices</td>
<td>6%</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Wet Lab</td>
<td>2%</td>
<td>36%</td>
<td>3%</td>
</tr>
<tr>
<td>Dry Lab</td>
<td>5%</td>
<td>26%</td>
<td>5%</td>
</tr>
<tr>
<td>Retail</td>
<td>11%</td>
<td>26%</td>
<td>2%</td>
</tr>
<tr>
<td>Residence</td>
<td>12%</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Athletics</td>
<td>9%</td>
<td>21%</td>
<td>16%</td>
</tr>
<tr>
<td>Library</td>
<td>6%</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

### 6.3.3 Future Targets

The targets will be revisited regularly (minimum annually) to ensure U of T remains in a leadership position.

How the targets step forward will be dependent on several factors, many of which are outside U of T’s direct control (e.g., the rate at which new technologies come to market). However, projects should anticipate a step forward in 2022 and 2026, as shown in Tables 6.3.4 and 6.3.5.

It is the responsibility of both the U of T Implementation Committee to verify and specify which iteration is to be used for the targets and estimated energy/carbon budgets.
6.3.4 Major Renovation: Targets for Scheduled occupancy between 2022 to 2026

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Interior Renovations: Target % Reduction</th>
<th>Mechanical Renovations: Target % Reduction</th>
<th>Envelope Renovations: Target % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>8%</td>
<td>33%</td>
<td>22%</td>
</tr>
<tr>
<td>Offices</td>
<td>8%</td>
<td>33%</td>
<td>22%</td>
</tr>
<tr>
<td>Wet Lab</td>
<td>3%</td>
<td>38%</td>
<td>3%</td>
</tr>
<tr>
<td>Dry Lab</td>
<td>6%</td>
<td>28%</td>
<td>6%</td>
</tr>
<tr>
<td>Retail</td>
<td>12%</td>
<td>28%</td>
<td>2%</td>
</tr>
<tr>
<td>Residence</td>
<td>13%</td>
<td>19%</td>
<td>19%</td>
</tr>
<tr>
<td>Athletics</td>
<td>10%</td>
<td>29%</td>
<td>18%</td>
</tr>
<tr>
<td>Library</td>
<td>7%</td>
<td>25%</td>
<td>22%</td>
</tr>
</tbody>
</table>

6.3.5 Major Renovation: Targets for Scheduled occupancy between 2026 to 2030

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Interior Renovations: Target % Reduction</th>
<th>Mechanical Renovations: Target % Reduction</th>
<th>Envelope Renovations: Target % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>8%</td>
<td>38%</td>
<td>25%</td>
</tr>
<tr>
<td>Offices</td>
<td>8%</td>
<td>38%</td>
<td>25%</td>
</tr>
<tr>
<td>Wet Lab</td>
<td>3%</td>
<td>45%</td>
<td>4%</td>
</tr>
<tr>
<td>Dry Lab</td>
<td>6%</td>
<td>33%</td>
<td>6%</td>
</tr>
<tr>
<td>Retail</td>
<td>14%</td>
<td>33%</td>
<td>3%</td>
</tr>
<tr>
<td>Residence</td>
<td>15%</td>
<td>21%</td>
<td>21%</td>
</tr>
<tr>
<td>Athletics</td>
<td>11%</td>
<td>34%</td>
<td>20%</td>
</tr>
<tr>
<td>Library</td>
<td>8%</td>
<td>30%</td>
<td>25%</td>
</tr>
</tbody>
</table>

6.3.6 Water

Where major renovation projects involve water fixtures, water consumption must be reduced as follows:

- Indoor water use must be reduced by 50% below the LEED™ version 4 baseline consumption.
- Outdoor water use must be reduced by 60% below the LEED™ version 4 baseline consumption.

The project team must submit a completed LEED™ v4 indoor water use reduction calculator and an outdoor water use reduction calculator to demonstrate the design fixture flush and flow rates will meet the required indoor and outdoor water use reductions.

The current excel based LEED™ v4 calculators can be found online on the New Construction website (refer to the Reference section for a direct link).
6.3.7 LEED™

LEED™ ID+C may be considered for renovation projects (minor and major) and also shadow LEED™ Silver minimum.

U of T recognizes LEED™ may not always be applicable for minor renovations and will assess on a project by project basis and announced within the issue of any design or project implementation tender documents.

If any renovation project requires an energy load model, LEED™ prescriptive compliance shall be considered. In all cases, the design team shall review the project scope in terms of LEED™ compliance by Project Initialization.

6.4 Documentation Requirements for Renovation Projects

To ensure projects are developing in accordance with the utility performance requirements, documentation must be completed by the Project Consultant Team and/or the U of T Implementation Committee at each project stage.

Table 6.4.1, below, summarizes the documentation that must be submitted at each stage of a renovation project. For each documentation item, the expectations and responsible parties are outlined in sections that follow.

### 6.4.1 Renovation Documentation Submission Requirements by Project Stage

<table>
<thead>
<tr>
<th>Documentation</th>
<th>PPR</th>
<th>Project Initialization</th>
<th>SD</th>
<th>DD</th>
<th>CD</th>
<th>Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Charter – PPR Form</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Charter – Design Form</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Charter – Project Submissions Checklist</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Utilities Performance Report</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Water Efficiency Worksheets</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Summary of Changes from Previous Submission</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Equipment Cut Sheets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>

6.4.2 Project Charter

The Project Charter has been developed to aid in the calculation of the project-specific performance targets and provide a central repository for the assumptions and design characteristics that drive the utility performance of buildings.

It is comprised of three parts: the PPR Form; the Design Form; and the Project Submissions Checklist.

The Project Charter serves as a reference point throughout the design process to ensure the performance goals are clearly understood by all involved parties and ultimately achieved.
Not all renovation projects require or prepare a PPR. The internal engineering department will prepare a scope of work to be completed and presented to the design team assigned.

All renovation Targets are relative to an approved baseline year energy performance calculated using actual utility data from the 12 months (min) before the project design start.

If actual utility data is not available, an estimated pre-project energy use index can be calculated from the existing building energy performance indicators for each space use, aggregated and applied to the area being renovated.

The energy and GHG use indices to calculate the baselines will be provided by the U of T Implementation Committee.

### 6.4.3 PPR Form

The PPR Form (or equal as a scope) of the Project Charter will be completed by the U of T Implementation Committee and provided to the Project Consultant Team.

The PPR Form will identify whether the project is a minor or major renovation project.

For major renovations, the PPR Form calculates project-specific performance targets based on renovation categorization, building use type, renovation project area, and historical building energy usage.

The PPR Form will be completed by Campus and Facilities Planning (or as assigned) in consultation with Facilities and Services. The PPR Form must be reviewed and approved by Facilities and Services (F&S) representatives as listed in Table 6.4.4:

<table>
<thead>
<tr>
<th>Campus</th>
<th>F&amp;S Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>St George</td>
<td>Paul Leitch, Director of Sustainability, St. George</td>
</tr>
<tr>
<td>Scarborough</td>
<td>Jeffrey Miller, Director of Facilities &amp; Services, UTSC</td>
</tr>
<tr>
<td>Mississauga</td>
<td>Ahmed Azhari, Director, Utilities &amp; Sustainability, UTM</td>
</tr>
</tbody>
</table>

### 6.4.5 Design Form

The Design Form of the Project Charter will be completed by the Project Consultant Team and reviewed and approved by the U of T Implementation Committee and F&S Representative.

- For major renovations, the Design Form is used to confirm the utility performance targets that were established on the PPR Form and record the proposed calculation methodology.
- For minor renovations, the Design Form is used to confirm which prescriptive measures are applicable to the project.
- For minor renovations with HVAC renovations, the Design Form is used to describe the proposed baselines and proposed energy reductions.
In addition to the completion of the Design Form, the Project Consultant Team may be asked to outline the intended reporting format for approval by the U of T Implementation Committee.

6.4.6 **Project Submissions Checklist**

The Project Submissions Checklist summarizes the documentation requirements and creates a centralized summary of the utility performance metrics at each submission.

The Project Consultant Team must complete and submit the checklist at each project milestone.

6.4.7 **Utilities Performance Report**

The Project Consultant Team shall submit a Utilities Performance Report to the U of T Implementation Committee outlining how the proposed renovation will achieve the required energy and water reduction targets as defined in the Project Charter.

The Utilities Performance Report must include:

- Description of the renovation elements that will impact building energy and water consumption;
- Description of the baseline energy and how it was calculated;
- Demonstration that the prescriptive requirements are met by the proposed renovation (minor renovation);
- Energy and water reduction calculation results, demonstrating achievement of the reduction target (major renovation) based against the approved baseline energy/GHG use; and
- Description of the calculation methodology.

6.4.8 **Water Efficiency Worksheets**

When applicable, the Project Consultant Team must submit a completed LEED™ v4 indoor water use reduction calculator and an outdoor water use reduction calculator to demonstrate the design fixture flush and flow rates will meet the required indoor and outdoor water use reductions.

The current excel based LEED™ v4 calculators can be found online on the LEED™ New Construction website (refer to the Reference section for a direct link).

6.4.9 **Summary of Changes**

For submissions that update previously submitted documentation, the Project Consultant Team must provide a summary narrative that clearly outlines any changes and/or assumptions.
6.4.10 Equipment Cut Sheets

Cut sheets and documentation shall be prepared and presented to the U of T Implementation Committee during the Project Initialization phase. Any changes to previously submitted documentation shall be accepted by the U of T Implementation Committee before including into the design. Data sheets will be used to verify proposed energy performance opportunities and during project commissioning.

7 ENERGY PERFORMANCE MODELLING REQUIREMENTS

7.1 Compliance

New construction and major renovations projects must demonstrate compliance with the energy performance targets as defined in the Charter using computer-based energy modelling software packages. All building components must be included in the energy model and may not be excluded as a result of any prescriptive requirements.

7.2 Simulation Software Specification

The simulation software must meet the requirements set out in ASHRAE Standard 90.1-2013 Clause G2.2 and be verified according to ASHRAE Standard 140. The Project Consultant Team is responsible for ensuring the simulation program used meets the criteria for acceptance by the authority having jurisdiction (AHJ).

7.3 Acceptance of Modelling Process

The U of T Implementation Committee shall review and accept the modelling process, software, input parameters, output format, energy metrics and results. The modeler will provide the model input and output files at each submission for U of T review, acceptance, and use. Modelling software used for renewable energy systems shall be presented to the U of T Implementation Committee for approval before being used.

7.4 Inputs not specified

Modelling inputs not specified in these standards shall represent the actual designs. Modelling software limitations shall not limit the accuracy of the energy modelling to show compliance with the standards targets. Project Consultants are expected to overcome software limitations with best practices engineering calculations. All other modelling inputs not discussed in these standards shall be based on best practices engineering.

7.5 Modelled versus actual Results
The results of modelling to meet these standards are intended for both regulatory purposes (when required) and to determine whether a project design complies with the targets and budgets established by the Charter. Through standardizing the target setting and modelling process, the U of T will be able to compare performance between buildings and post-occupancy.

7.6 Resubmission of Performance Model

When the energy modelling submission or performance results are not accepted by the U of T Implementation Committee at any design stage, revised design model input parameters shall be implemented and rerun by the Project Consultant Team and resubmitted for approval before proceeding to the next design stage.

7.7 Minor Renovation Energy Model

Minor renovations may not require energy modeling except when HVAC systems are affected. Internal or external engineering services may be used to design the HVAC system upgrade (e.g., rooftop unit replacement).

Sizing modelling for HVAC upgrades/replacement shall be treated as energy performance modelling. Energy performance results shall be presented and compared to the calculated energy performance baselines.

7.8 Energy Performance Model delivery

The Project Consultants shall meet with the Project Management and F & S teams at Project Initialization to ensure the appropriate targets are defined. When an energy performance model is required to size the renovation, the model shall be presented to the U of T design team responsible and accepted before the renovation design is implemented.

In all cases, high performance and reduced GHG targets are to be pursued.

7.9 Model Input Modifications

The energy modelling team shall be prepared to modify inputs through the design process within reason. Modifications required as a result of design changes to meet the targets shall be carried out as within scope.

Alterations or parametric evaluation requested during the design process shall be discussed with U of T and the Project Consultant before the work is started and approved by U of T Implementation Committee.

They shall be prepared to revise the final energy performance model as a result of commissioning should the results of the commissioning indicate differences in design criteria that will materially affect the energy performance estimates.

Modelling tools or software shall not be changed during the project without approval by the U of T Implementation Committee.
7.10 Post Occupancy Evaluation

If the actual energy performance after 12 months of continuous operation exceeds the predicted performance by more than 15%, the design team/modelers will be asked to comment and assist U of T to determine the possible reasons for the variation.

7.11 Climate Data

Unless otherwise stated by the U of T Implementation Committee, the energy model shall use the following hourly weather data, in the form of Canadian Weather Year for Energy Calculation (CWEC_v_2016) datasets from the Government of Canada, available for free download at https://climate.weather.gc.ca/prods_servs/engineering_e.html.

- Projects on St. George and UTSC campuses shall use the CWEC_v_2016 file: CAN_ON_TORONTO-CITY_6158355_CWEC
- Projects on UTM campus shall use the CWEC_v_2016 file: CAN_ON_TORONTO-INTL-A_6158731_CWEC
- Where required, Climate Zone 6A shall be used. Note that this zone is showing a trend to a lower zone category.
- For projects beyond 2030, review of the zone category will be required and moving to zone 5A will be considered for use post-2030.

7.12 Greenhouse Gas Emission Factors

Projects shall use the greenhouse gas emission factors listed in the Ontario Building Code 2012 Supplementary Standard SB-10 2017 Division 3, Chapter 1, Table 1.1.2.2. “CO₂e Emission Factors.” Electricity and natural gas emission rates are listed for convenience in Table 7.10.1 below. These factors may be subject to review and adjustment by U of T.

When renewable energy systems are installed, an annual marginal emissions factor shall also be used to calculate annual emissions avoided and presented along with the results of the emissions avoided using the factors in Table 7.10.1.

### 7.12.1 GHG Emission Factors

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Annual GHG Emission Factor</th>
<th>EF Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased</td>
<td>0.043</td>
<td>kg CO₂/kWh</td>
</tr>
<tr>
<td>On-site Generation</td>
<td>0.04</td>
<td>kg CO₂/kWh</td>
</tr>
<tr>
<td>Marginal generation*</td>
<td>0.148</td>
<td>kg CO₂/kWh</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1.899</td>
<td>kg CO₂/m³</td>
</tr>
</tbody>
</table>

*Marginal emissions factors will be calculated and presented in energy modeling reports as well as those from on-site generation. U of T will use this information internally and to report to AHJ as required.

7.13 Thermal Plant Equipment
Projects connecting to U of T district energy systems shall model the building using a “virtual plant” with the characteristics outlined in Table 7.11.1 below unless otherwise specified/approved by the Implementation Committee. Greenhouse gas emission factors are applied per Section 7.10 based on the listed fuel type.

### 7.13.1 District Energy System Connection Characteristics

<table>
<thead>
<tr>
<th>District Connection</th>
<th>Virtual Plant Total Average Efficiency</th>
<th>Fuel Type</th>
<th>GHG Emission Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>80% efficient</td>
<td>Natural Gas</td>
<td>1.899 kg CO₂e/m³</td>
</tr>
<tr>
<td>Cooling</td>
<td>COP of 5.5</td>
<td>Electricity</td>
<td>0.050 kg CO₂e/kWh</td>
</tr>
</tbody>
</table>

Projects with on-site plant equipment shall be modelled according to the proposed mechanical design characteristics. For buildings with hybrid systems (e.g., district heating with on-site cooling), the district connections shall follow the above virtual plant characteristics while the on-site equipment shall match the mechanical design characteristics.

Hybrid buildings are considered “District Connected” when calculating performance targets using the Project Charter.

### 7.14 Other Modelling Requirements

The model should reflect U of T values for schedules, set points, occupancy density, and space loads so there is consistency between modelling phases.

The Project Consultant Team shall ensure the modelling variables required by U of T are completely understood and utilized.

If there is a reason to believe values for the modelled building will not be in alignment with the schedules defined in the Design Form of the Project Charter, the modeler shall bring this to the attention of U of T and propose more appropriate values.

The Project Consultant team shall not assume conventional occupancy schedules are always appropriate for U of T and shall be presented to U of T for verification before these are used in the models.

The Project Consultant Team must take responsibility for their ultimate approval.

### 7.15 Air infiltration Rate

During the design phases of the project, air infiltration shall be modelled at the target whole building air leakage rate for the project, as recorded in the Design Form of the Project Charter. The Occupancy Submission energy model must be modelled using the actual tested air leakage rate.

Note that air leakage test results are often normalized by the total envelope surface area, which is different than the above ground wall and window areas, due to the inclusion of floors and roofs. When converting from an air leakage test to modelled infiltration or vice-versa, the difference in surface areas must be accounted for.
Projects proposing reduced infiltration rates will be required to prepare and present documentation to support the use of and means to verify the lower rate. The University is interested in assessing the value of reduced infiltration rates and encourages the modeling team to prepare standard and reduced infiltration models to illustrate the effect on the energy and GHG budgets.

7.16 Enclosure Performance

The enclosure components must be modelled using effective thermal performance following the guidance in the TGS version 3 Energy Modelling Guidelines, “Calculating Envelope Heat Loss”. Refer to the References section for a direct link.

8 REFERENCES


**New Construction Project Charter**

**PPR Form**

### Project Characteristics

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<th>Project Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Proposed Occupancy Date</td>
<td>2022-2026</td>
</tr>
</tbody>
</table>

### Programming Breakdown

Categorize the project's programmed areas as net assignable floor area ("NASM") into the appropriate use-types, following the descriptions provided below. Apply multipliers as appropriate to reach the total anticipated gross floor area ("GSM") of the project. When all space uses have been assigned, the total NASM and GSM should align with the PPR.

<table>
<thead>
<tr>
<th>Space Use Types</th>
<th>NASM (m²)</th>
<th>Multiplier</th>
<th>GSM (m²)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residence Space</strong> - including living quarters, amenity and common spaces, laundry rooms, etc.</td>
<td>1,250.0</td>
<td>1.0</td>
<td>1,250.0</td>
<td></td>
</tr>
<tr>
<td><strong>Retail Space</strong> - including sales area, kitchen, dining/seating area, servery, etc.</td>
<td>150.0</td>
<td>2.0</td>
<td>300.0</td>
<td></td>
</tr>
<tr>
<td><strong>Athletic Space</strong> - including exercise rooms, gymnasiums, change rooms, lockers, multi-purpose rooms, etc.</td>
<td>100.0</td>
<td>2.0</td>
<td>200.0</td>
<td></td>
</tr>
<tr>
<td><strong>Wet Laboratory Space</strong> - laboratory and lab support/storage spaces that have high ventilation exhaust requirements and high equipment power density.</td>
<td>0.0</td>
<td>2.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td><strong>Dry Laboratory Space</strong> - laboratory and lab support/storage spaces that have high equipment power density but no ventilation exhaust requirements.</td>
<td>0.0</td>
<td>2.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td><strong>Office Space</strong> - including staff, faculty &amp; grad offices, and associated areas</td>
<td>2,000.0</td>
<td>2.0</td>
<td>4,000.0</td>
<td></td>
</tr>
<tr>
<td><strong>Academic Space</strong> - including classroom and lecture, meeting rooms, multipurpose academic spaces, etc.</td>
<td>1,000.0</td>
<td>2.0</td>
<td>2,000.0</td>
<td></td>
</tr>
<tr>
<td><strong>Library</strong> - stack, reading rooms, meeting rooms, study areas</td>
<td>100.0</td>
<td>1.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td><strong>Other Areas</strong> - any spaces not attributed above</td>
<td>150.0</td>
<td>1.0</td>
<td>150.0</td>
<td></td>
</tr>
</tbody>
</table>

**Total (m²)**

| 4,750.0 | 8,000.0 |

**Connected to District Steam System?**

- **No**

  "No" assumes heating by low temp source (<65°C)

  "Yes" assumes high temp heating (>65°C)

### Performance Targets

| Performance Budgets |
|---------------------|-----------------|-----------------|
| **Total Energy Use Intensity** | 72.8 ekWh/m²/yr | 582,019.8 ekWh/year |
| **Greenhouse Gas Intensity** | 5.2 kg CO₂e/m²/yr | 41.3 tonnes CO₂e/year |
| **Heating Thermal Energy Demand Intensity** | 35.4 ekWh/m²/yr | 283,128.7 ekWh/year |
| **Cooling Thermal Energy Demand Intensity** | 22.7 kWh/m²/yr | 181,544.6 ekWh/year |
| **Indoor Water Use Reduction** | 50% | |
| **Outdoor Water Use Reduction** | 60% | |
| **On-Site Renewable Requirements** | 5% | |

### Charter Agreement

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<th>Role</th>
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<th>Date</th>
</tr>
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<tr>
<td>Design Team Leader</td>
<td>AT</td>
<td>PDL</td>
<td>7/1/2020</td>
</tr>
<tr>
<td>F &amp; S Team leader</td>
<td></td>
<td></td>
<td>7/1/2020</td>
</tr>
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</table>
ELECTRICAL DESIGN STANDARDS

Introduction

The following are the University of Toronto Electrical Design Standards. The information contained within these Standards must be followed unless:

1. They cannot be applied to the specific design work planned. If this is a problem, the design consultant must present the information to the U of T Project Manager to point out the problem and receive permission to implement the alternative solution.

2. If an alternate product or system is available, which is the recommended standard of the consultant for the project; they may request approval for such an alternate through the U of T Project Manager.

3. If there is a conflict between these Standards and the Codes, such issues should be brought to the attention of the U of T Project Manager for a decision on what to use.

4. If there is a substantial cost savings to be realized by changing from a standard and the consultant is recommending such a saving, the U of T Project Manager will consider such a request. The consultant might be requested to prove the cost savings compared to long term maintenance costs.

5. The consultant is encouraged to point out any problems with the Standards, and to provide alternates that may have a significant cost savings. The consultant is also encouraged to comment on the appropriateness of the Standards as compared to general industrial standards.

6. These Standards are intended to be competitive standards. However, the consultant should understand that the University would like to achieve more permanence and lower long term maintenance in the products that are purchased and installed. Therefore, the Standards might be slightly higher than the normal commercial standards.
# Electrical Design Standards (Division 16)

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<td>16461.1</td>
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**Electrical Design Standards - Checklist**

The Design Team is required to read and comply with the full Design Standard as it applies to this project. A completed copy of this checklist must be submitted by the Design Team to the University’s Project Manager at the end of the Design Development Phase. In all cases, if a “NC” has been noted, please indicate why. Attach additional sheets as necessary.

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<tr>
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<th>NC</th>
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<td>Conduits (Electrical Distribution, Telephone, Computer and Control Wiring)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.1</td>
<td>All conduits inside the building shall be electrical metallic tubing (EMT) unless specified otherwise.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.2</td>
<td>Conduits exposed to the weather, in wet locations, subject to mechanical injury, or in any hazardous locations or where required by Code, shall be rigid threaded, galvanized steel conduit.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.3</td>
<td>Conduits in ceiling plenums shall be EMT.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.4</td>
<td>Motor feeder drops shall be in rigid threaded galvanized steel conduit with a maximum 3'-0&quot; (1m) and of flexible liquid-tight conduit for final connection to motor. Rigid conduit for the drops shall start at least 3'-0&quot; (1m) ahead of the actual bend and have two additional clips over normal requirements. The minimum conduit size for the drops shall be 3/4&quot; (19mm).</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.5</td>
<td>Branch wire conduits in finished areas shall be concealed and those in unfinished areas shall be surface mounted unless otherwise noted.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.6</td>
<td>Conduits shall be installed so that the conductors can be drawn in without strain or damage to the conductors.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.7</td>
<td>Expansion fittings shall be installed in conduits crossing expansion joints.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.8</td>
<td>Conduits shall be installed to allow for expansion and expansion fittings shall be provided where required.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.9</td>
<td>The use of running threads shall not be permitted. Ericson couplings shall be used where required.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.10</td>
<td>Connectors for EMT conduit shall be steel, compression type, nylon insulated. Steel set screw type is acceptable.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.11</td>
<td>Fish wires shall be installed in all empty conduits, including telephone and computer conduits.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.12</td>
<td>A separate insulated ground wire shall be installed in all conduits, except computer telephone/control conduits.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.13</td>
<td>Joints in conduits installed underground, in concrete slab on grade or in a concrete duct bank shall be made completely watertight.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
.14 Minimum concrete thickness over or around a conduit in a concrete slab shall be 3" (75mm).

.15 Conduits for computer systems shall comply with Enterprise Infrastructure Solutions (EIS) Standards.

16118 **Ductbanks and Cable Chambers**

.1 Duct banks shall consist of parallel conduit(s) encased in concrete. At the supply end, bell end couplings shall be used to terminate the ducts.

.2 The ducts shall be CSA certified, PVC Type 2 with an internal diameter of 6" (150mm), and shall include the duct manufacturer’s watertight couplings, duct bends and duct supports.

.3 Adjacent duct couplings shall be staggered by at least 8" (200mm) with a duct support within 24" (600mm) either side of the furthest couplings.

.4 Duct bends shall be paralleled sweeping type, with minimum bending radius of the inside bends sized to suit the recommended bending radius of the largest cable that will be installed in the duct bank.

.5 The ducts shall be laid with a minimum spacing of 8" (200mm) centre to centre, both horizontally and vertically, or as the duct manufacturer’s duct supports for concrete encasement dictate.

.6 The duct run shall be reinforced with minimum 1/2" (13mm) diameter PVC coated steel reinforcing rods laid longitudinally on top, bottom and sides of duct bank and secured to the duct manufacturer’s duct supports. Where reinforcing rod overlap occurs between duct supports, they shall be overlapped a minimum of 12" (300mm) and tied together.

.7 The ducts shall be encased with minimum 2,000 psi concrete with a minimum cover of 3" (75mm) on all sides.

.8 To prevent any displacement of the duct structure during pouring, the duct structure shall be braced down every 10 feet (3m) and the concrete shall be deflected down alongside the ducts to the bottom and up through the duct assembly.

.9 The duct bank elevations shall be arranged to slope downwards towards the termination points (building or manhole) such that water cannot accumulate anywhere along the length of the duct bank. In no case shall the highest elevation of the duct bank be less than 36" (900mm) below grade.

.10 The ducts entering into buildings, substations or manholes shall be bell shaped and sealed.
.11 When completed, the ducts shall be cleaned. Cleaning shall include a properly sized steel brush mandrel pulled through each duct, followed by swabbing to ensure removal of all dirt and other debris that could damage cable insulation. A test piece of the largest cable to be installed in the duct bank shall be pulled through each duct to ensure no cable insulation damage will occur. When each duct has been proven, the ends shall be plugged.

.12 One continuous length of ½” (13mm) diameter polyethylene rope shall be installed in each duct to facilitate the installation of the cables in the duct.

.13 Cable Chamber
   .1 Cable chamber cover shall be minimum 33 inches (840 mm) in diameter.
   .2 Cable chamber shall be minimum 6 feet x 8 feet (or 1.8m x 2.4m).
   .3 Cable chamber shall be provided with means of drainage.
   .4 Cable chamber floor shall be sloped into a sump pit.
   .5 Provide cable pulling eyes cast into the walls. Cable pulling eyes shall be located opposite to ductbanks entering cable chamber.
   .6 Bottom of cable ductbanks entering cable chamber shall be at least 2 feet (600mm) from cable chamber floor.
   .7 Cables inside cable chamber shall be properly supported by cable racks.
   .8 Height of cable chamber shall be minimum 6’ – 6” (2m).

16121 Loop Feeder High Voltage Cables (15 kV)

   .1 Materials
      .1 Cables shall be 750 kcmil copper conductor, triplexed, rated 15 kV, 133% insulation level, manufactured and tested to ICEA Publication S-93-639, and shall be CSA or UL approved* and bear evidence of same. (* where accepted by Code)
      .2 The cable shall be Class "B" stranded copper with 61 strands, extruded semi-conducting polyethylene shield, Exelene insulation, extruded semi-conducting polyethylene shield, wire shielding composed of 29 #10 AWG soft tinned copper strands for a short circuit rating of 10,500 Amps for 8 cycles covered with a separator and an overall PVC jacket. Insulation shall be tree retardant TRXL and shall bear evidence of same. Cables to be supplied in continuous lengths, free from kinks and defects.
## Installation

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<th>NC</th>
<th>N/A</th>
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- Before pulling the cable into a duct, clean the duct by pulling through a stiff wire brush, and a swab to remove all water, mud, sand, earth and other foreign matter. A test piece of the cable shall be pulled through the duct to ensure cable insulation will not be damaged.

- Install cables in continuous lengths without splices, unless specifically indicated otherwise.

- Use pulling eyes to install the cables.

- Use a good quality, cable manufacturer’s approved lubricant in sufficient quantity for the pulling operation. The lubricant shall possess the following characteristics:
  - No harmful effect on cable jacket.
  - Percentage of water content (if water based) shall be minimal.
  - Retention of lubricant qualities over a long period of time.
  - Shall not freeze in cold weather (above 0 °F).
  - Shall be approved by C.S.A. for the cables being installed.

- Terminate and splice cables in accordance with the cable manufacturers' recommendations, using only the methods, materials and compounds recommended.

- Each splice and stress cone termination shall be a built-up type, generally consisting of approved compression type connector, insulating tape, semi-conducting tape, self-amalgamating polyethylene tape, insulating shielding and a copper braid cover connecting at both ends to the shield, equal to shielding of cable.

- Splicing and stress cone termination shall be performed by a trained and qualified splicing and testing company approved by the U of T, experienced in preparing the cable and the type of splicing work called for by the nature of this work and in accordance with the cable manufacturer's recommendation.

- Hi-pot the complete cable installation, including terminations, in accordance with the applicable CSA and ICEA Standards, and submit written report of Hi-pot test.

- Install cables in accordance with the manufacturer's recommendations for the specific type of cable and installation conditions.

- Cables in HV Substations or cable chambers shall be properly identified with permanent labels.
16123  **Wires and Cables**

.1 Wires and cables (120/208V to 347/600V systems) unless otherwise noted, shall be minimum size #12 AWG, stranded, copper conductor, type RW90 (90°C) or THHN, minimum 600 Volt insulation. ALUMINUM CONDUCTOR CABLES SHALL NOT BE USED.

.2 Type AC90 (BX) armoured cable shall only be used for fixture down drops above accessible drop ceilings with a maximum down drop not to exceed 3 metres (10 feet) from ceiling junction box to fixture. Armoured cable may be used for single drops from the junction box to supply wiring devices in drywall partitions.

.3 M.I.C.C. cables shall have solid copper conductors insulated with magnesium oxide and enclosed in a seamless copper sheath with a protective jacket where required. M.I.C.C. cables shall be identified with colour codes (see section 16130) every 10ft. (3m) of cable run.

.4 M.I.C.C. cables shall be terminated with moisture proof connectors.

.5 Size wiring for a 2% maximum voltage drop to farthest outlet based on circuit rating. Home runs to lighting and receptacle panels which exceed 75 ft. (25m) shall be minimum No. 10 AWG. For -80°C Freezer wiring:
   - if longer than 50ft. (15m), use minimum No.10 AWG;
   - if longer than 100ft. (30m), use minimum No.8 AWG;
   - if longer than 150ft. (45m), not recommended.

.6 Termination lugs for feeder cables shall be compression type.

.7 All outdoor wiring shall have copper conductors with RWU-90, X-Link, minus 40°C, 600 Volt insulation.

.8 When a project is to include new wiring, wiring upgrades or rewiring, all the existing wiring that is no longer in service shall be removed as part of the project. New panel and equipment names shall be approved by the Manager of Electrical Systems.
## Colour Codes for Junction Box Cover Plates on Various Systems

<table>
<thead>
<tr>
<th>System</th>
<th>Colour Code</th>
<th>Written Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/208V</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>-Normal lighting and power</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>-Emergency power</td>
<td>White / Red</td>
<td></td>
</tr>
<tr>
<td>-UPS</td>
<td>White / Blue</td>
<td></td>
</tr>
<tr>
<td>240/416V</td>
<td>Pink</td>
<td></td>
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<td>Pink</td>
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<tr>
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<td>Pink / Red</td>
<td></td>
</tr>
<tr>
<td>-UPS</td>
<td>Pink / Blue</td>
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</tr>
<tr>
<td>346/600V</td>
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<tr>
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</tr>
<tr>
<td>Fire Alarm</td>
<td>Red</td>
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</tr>
<tr>
<td>Telephone</td>
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<td></td>
</tr>
<tr>
<td>Cable TV</td>
<td>Purple</td>
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</tr>
<tr>
<td>Data</td>
<td>Brown</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Green</td>
<td></td>
</tr>
<tr>
<td>-HVAC</td>
<td>Green</td>
<td></td>
</tr>
<tr>
<td>-L.V. Lighting control</td>
<td>Green / Black</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>Grey</td>
<td></td>
</tr>
<tr>
<td>Surveillance, CCTV</td>
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<tr>
<td>Paging</td>
<td>“PG”</td>
<td></td>
</tr>
<tr>
<td>Intercom</td>
<td>“ICOM”</td>
<td></td>
</tr>
</tbody>
</table>

Note: Light colours shall be chosen for Green, Blue, Brown, and Grey.

.1 All junction box cover plates on various systems shall be colour coded according to the Table shown above.
.2 Mark in black on the colour coded cover plates the year when this colour code was applied. Use 4-digit numbers to represent the year.

## Wiring Devices

.1 Light switches on 120 Volt circuits shall be rated 20 Amp.
.2 Light switches in all areas shall be premium specification grade, A.C., toggle type switches, except where required in washroom or corridors which shall be key operated.
.3 Receptacles shall be premium specification grade.
.4 Light switches and receptacles on normal power shall be white.
.5 Light switches and receptacles on emergency power shall be red.
.6 Isolated ground receptacles shall be orange.
.7 Wall plates for flush mounted devices shall be multiple gang, super stainless steel type 302.
.8 Wall plates for surface mounted devices in unfinished areas shall be metal covers for F.S. type boxes.  
.9 Weatherproof plates shall be cast aluminium with lift cover for F.S. type boxes.  
.10 The A.V. and computer outlet wall plates shall be provided as required by Enterprise Infrastructure Solutions (EIS).  
.11 The telephone outlet wall plates shall be provided as required by Enterprise Infrastructure Solutions (EIS) standards.  
.12 The dimmers up to 1500W shall have linear slide control, white finish and lamp debuzzing coil in aluminium enclosure, equal to Lutron `Nova' series. For low voltage dimming, use `Nova NLV' series.  
.13 Mounting heights are referred to finished floor or finished ceiling unless related to bench mark elevations.  
.14 Provide cover plates for flush mounted manual starters.  
.15 Light switches, except where noted, shall be mounted 4'-0" (1,200mm) above finished floor, on the lock side of the door.  
.16 Telephone, intercom, etc., wall outlets shall be spaced 4" (100 mm) from power outlets.  
.17 Opposing outlets on partition walls shall have a 6" (150 mm) horizontal separation. They shall not be mounted back to back.  
.18 All Receptacle outlets shall be permanently identified indicating the circuit number and source of supply (e.g. Panel board designation).
Numbering System for Electrical Panels

Example: LP3A1A (or LP – 3 – A – 1 – A )

- Type:
  - MCC = Motor Control Centre
  - DP = Distribution Panel (Subfeeds other panels PP, RP, or LP)
  - SP = Splitter
  - PP = Power panel
  - RP = Receptacle panel
  - LP = Lighting panel
  - LVP = Low voltage control panel

- Voltage Level:
  - A = 120/208V
  - AA = 240/416V
  - AAA = 600/347V

- Panel No.:
  - e.g. 1, 2, 3...

- Pony Panel:
  - e.g. A, B, ...

- Floor:
  - e.g. SB = Sub-basement
  - B = Basement
  - 1 = Ground Floor
  - 2 = 2nd Floor
  - PH = Penthouse
13.8 kV Liquid Filled Power Transformers (Indoor Type)

.1 Power transformers shall be silicone oil liquid filled, sealed tank, self-cooled, type LNAN-LNAF, 2 winding, step down, with a temperature rise at rated self-cooled load of 55°C over an ambient of 40°C maximum and 30°C average.

.2 Transformers shall comply with the applicable standards of CSA, CEMA, ANSI and NEMA.

.3 The capacity of each transformer shall be:
   - 100% kVA at 55°C rise without fans;
   - 112% kVA at 65°C rise without fans, with no loss of transformer life;
   - 133% kVA at 65°C rise with fans, with no loss of transformer life. Fans shall be provided.

.4 High voltage windings shall be 13.8 kV, delta connected, with four 2.5% rated kVA taps, two above and two below nominal voltage.

.5 Low voltage windings shall be wye connected, with the wye connection solidly grounded outside the tank.

.6 The basic impulse insulation (BIL) level shall be 95 kV.

.7 The impedance shall be between 5.5% and 6.3%, including all tolerances.

.8 Transformers shall be complete with all standard accessories, including, but not limited to, the following:
   - Off load circuit tap changer operable from ground level by a single external wheel, with provision for padlocking in any position.
   - Tap position indicator.
   - High internal tank pressure relief device.
   - Hermetically sealed dial type oil temperature thermometer, three stages: fan start, alarm and trip contacts.
   - Liquid level gauge with alarm contact.
   - Bottom drain valve and sampling device.
   - Two tank grounding studs for No. 4/0 AWG conductor in diagonally opposite positions.
   - Lifting eyes, welded bottom corner jacking steps and provision for skidding.
   - Diagrammatic nameplate of non-corroding material in an accessible location.
   - Sudden gas pressure relay with trip and alarm contacts. Seal-in or lockout relays shall operate on 125V DC.
   - Winding temperature sensors with winding temperature alarm contacts for remote connection.
9 A sprinkler proof control panel for the transformer forced air cooling supply and control, transformer local audible and visual alarms and auxiliary relays for local and remote trip and alarms, shall be mounted on the transformer. Control panel shall have a hinged access door. Visual alarms shall be LED type annunciation lamps, one per individual alarm, and shall be located on the front door of the control panel. Audible alarm shall be minimum 4" (100 mm) horn mounted on the front of the control panel door.

10 The control panel power supply shall be wired from the secondary of the power transformer and shall include necessary transformation to 120 vac. The control panel shall incorporate main fusing and wiring sized for fan supply requirements, fused control transformer and fans contactor and associated on-off- auto control switch, local alarm bell, and auxiliary relays as required for local and remote alarm requirements.

11 All wiring shall be provided between the transformer control panel and transformer cooling fans and temperature and pressure alarm and trip contacts.

12 The control panel shall have the necessary auxiliary relays as required and terminal blocks for local and remote wiring to satisfy the following:
Note: LOCAL ALARM is control panel audible and visual alarm indication. REMOTE ALARM & TRIP is termination at control panel terminal block for remote connection for each of alarm or trip connections.
CONDITION: Low Oil Level: Local & Remote alarm.
CONDITION: Oil Temp: 1st stage - START FANS; 2nd stage - Local and Remote Alarm; 3rd stage - Remote Trip.
CONDITION: High Winding Temp: Local & Remote Alarm.
CONDITION: Sudden Gas Alarm: Local and Remote Alarm.
CONDITION: Sudden Gas Trip: Remote Trip.

13 All local alarm and remote alarm and trip auxiliary relays in the control panel shall be seal-in and an alarm horn silencing switch with ring back feature together with a manual reset switch located in the control panel shall be provided to reset all auxiliary relays.

14 Windings and all current carrying conductors shall be copper.

15 Transformers shall be factory finished ANSI 61 grey.

16 Provide transformer oil analysis in accordance with ASTM standards.
16346 **13.8 kV Indoor Switchgear for 13.8 kV Loop Network**

Note: Toronto Hydro requirements are quoted for Short Circuit Levels and Ratings.

16346.1 **General**

.1 The switchgear shall consist of an assembly of incoming loop and tie circuit breakers, fusible and non fusible load break switches, protective relaying, metering and ancillary equipment, configured as shown on the drawings. Cells shall be numbered from left to right when facing the front of the switchgear. Bus A shall be the left hand bus, and bus B the right hand bus.

.2 The completed assembly shall comply with the requirements of all Authorities having jurisdiction and including Canadian Standards Association C22.1, C22.2 Nos. 31, 94, 193 and CAN3-C13; EEMAC G8-3.2; IEEE Standard 48-1975; ANSI Standard C37.85-1972; Ontario Electrical Safety Code; ANSI C37.04 to C37.18 and C37.20. Where U of T requirements exceed those of the foregoing Standards, those U of T requirements shall be met.

.3 The switchgear shall include the required number of cells, bolted together on a common channel steel base to form a self-contained, self-supporting, dead front assembly.

.4 The switchgear shall comply with the following minimum ratings (as per Toronto Hydro requirements):
- Continuous current rating: 1200 A rms (main bus);
- Max Short Circuit rating: 500 MVA;
- Symmetrical Max Ground Current rating: 11,000 amps;
- Rated Nominal Voltage: 13.8kV rms;
- Rated Max Voltage: 15kV rms;
- Rated Frequency: 60 Hz;
- Power Frequency Withstand Voltage: 36 kV;
- BIL: 95 kV;
- Rated Momentary Current: 37 kA rms;
- Asym Corona Extinction Voltage to Ground: 10.5 kV rms.

.5 The integrated assembly shall be designed to withstand any internal pressures that may be created when a switch or breaker opens, carrying full rated current, or is closed on a fault or when the fuses operate or a breaker trips under full rated fault conditions.

.6 All electrical and mechanical interlocks required for the protection of equipment and personnel shall be included.

.7 Provide Arc Flash calculations and Arc Flash warning labels on switchgear front panel.
16346.2 **Construction**

.1 The enclosure shall be sprinkler proof, minimum #11 MSG for the enclosure and barriers between compartments, and all other covers, barriers, panels and doors not less than #14 MSG.

.2 Circuit breaker cells shall be metalclad construction and divided into 4 separately grounded steel compartments for each of the following:
   1) Breaker compartment;
   2) Cable entry and termination compartment;
   3) Main bus and current transformers compartment;
   4) Metering, relaying and auxiliary devices compartment.

.3 Load break switch and bus transition cells shall be metal enclosed construction. Cells and compartments within cells shall be designed such that failure of any device within a cell or compartment shall not cause damage within adjoining cells and compartments.

.4 Mounting channels and hardware shall be supplied by the switchgear manufacturer for concrete pad installation in order to ensure proper levelling of the switchgear.

.5 Doors on the front of the switchgear shall be full height, formed type, with 3 point latches, concealed left hand hinges, stops and provision for multiple padlocking. A separate door for access to the breaker compartment and separate door for access to the upper compartment above the breaker compartment shall be provided on circuit breaker cells. Outer access door swings on all cells shall be minimum 135 degrees.

.6 A hinged steel panel with provision for padlocking shall be provided on the rear of each cell for access into the rear of the cell. For incoming HV cables into circuit breaker cells, a separate hinged panel shall be provided for the upper incoming cable compartment and for lower rear breaker compartments. Opening panels shall require unsecuring knurled 25mm head captive bolts on the opening side of panel and removal by the owner of his padlock. Hinged panels shall open a minimum of 135 degrees.

.7 Openings each c/w bolted sheet steel cover plate shall be provided at each end of the switchgear, to permit extension of the main bus and ground bus for future cells. Main bus openings shall be sized to allow for installation of bus and feed through insulators.

.8 The exterior finish shall be factory finished ANSI 61 grey and the interior finish shall be white enamel. A sufficient quantity of touch-up enamel shall be furnished to repair minor damage to the finish after installation.
16346.3  **Buses**

.1 Buses shall be high-conductivity copper with silver-plated joints and tap connections.  

.2 Buses shall be fully insulated using bed fluidized process. Through-bushings where buses pass through metallic barriers shall be fully rated for the insulation level of the switchgear and provide full cell separation between cells. Insulation and bushings shall be flame resistant and track retardant.  

.3 Bus joints shall be secured with cadmium plated steel bolts, nuts and washers to ensure maximum pressure and even current distribution. Bolts shall be tightened to required torque with a minimum of two bolts at each joint or as per bracing requirements.  

.4 Joint covers shall be non-flammable, non-tracking, and flexible, sized to suit the joint. Joint covers having to be shipped loose shall be installed at the site by qualified personnel. Cover fastenings (e.g. nylon bolts and nuts) shall be reusable.  

.5 Field connections on the buses shall be made using materials and methods supplied or recommended by the manufacturer.  

.6 The main bus shall be rated 1200 amps at 50°C ambient temperature and shall extend throughout the switchgear, complete with all required insulators and through-bushing supports. Bus shall be predrilled to allow for all HV cable terminations in the incoming HV cable compartments.  

.7 A 600 amp copper ground bus shall be run the full length of the switchgear. The ground bus shall be installed immediately inside the bottom lower rear of each circuit breaker cell and immediately inside the bottom lower front of each load break switch cell, allowing the owner to attach external grounds for owner maintenance testing and maintenance grounding requirements without interference from the main bus. Provide a pressure connector at each end of the switchgear ground bus for connecting a #4/0 AWG station grounding conductor. The switchgear framework and the bases and enclosures of all equipment shall be bonded to the ground bus.  

.8 Ground bus extensions with lugs shall be provided in the incoming HV cable compartments to allow the stress cones on the incoming cables to be grounded with short leads.  

.9 Provision shall be made for extending the main bus and ground bus at each end of the switchgear for extension to future switchgear cells. This shall include main bus predrilled bus stubs and insulating boots over the stubs, and predrilled ground bus.
16346.4 **Wiring and Connections**

.1 Provision shall be made for incoming HV cables entering the top of the switchgear, and outgoing HV cables leaving the top of the switchgear. A removable non ferrous cable entry plate shall be provided on the top of each cell for incoming or outgoing HV cables.

.2 Secondary wiring (including control, metering and relaying wiring) shall be run in grounded steel compartments or shall be otherwise suitably isolated from the high voltage bus and wiring.

.3 Secondary wiring shall be identified at each point of connection and termination by non-metallic wire markers, Brady or equal, to agree with the wiring diagrams.

.4 Secondary wiring shall be terminated with solderless lugs. Wiring shall be free of splices.

.5 Terminal blocks shall be provided to terminate non current transformer wiring within cells and between cells of the HV switchgears. Terminal blocks shall be barriered type, clearly identified with permanent markers. Terminal blocks shall have no more than one wire under each terminal connection. Providing manufacturer’s jumper connections between terminals as required to comply.

.6 Secondary wiring shall be minimum #12 AWG copper, switchboard type; 7 strand for fixed wiring and 41 strand for wiring to hinged panels.

16346.5 **Control, Metering and Relaying**

.1 Circuit breaker control switches, status and trip indicating lights, lamp test switches, meters and associated switches, relays, and all associated current transformer test blocks, shall be mounted on formed front hinged doors of the switchgear.

.2 Circuit breaker control switches shall be pistol grip type, 3 positions (close-open-trip) with target indication of the last operation and spring return to the open position. Target indication shall be red for breaker closed and green for breaker open. The control switch contact arrangement shall be arranged such that when a breaker trip occurs under fault conditions, the control switch must be operated from the “open” to “trip” position in order to extinguish the fault trip indicating LED (LED is separate from the control switch)
.3 All Indicating lamps shall be LED type and provided with external resistor to prevent inadvertent tripping of circuit breaker if the LED short circuits, rated nominal 125 VDC with operating range from 90 to 140 VDC. LED indication shall be provided on the respective circuit breaker cell for circuit breaker closed, open and fault trip indications, transformer sudden gas trip indication, transformer oil-temperature trip indication, and circuit breaker low SF6 pressure indication (if applicable). Push to test switch(es) shall be provided to test the integrity of all LEDs.

.4 Meters shall be semi-flush mounted, switchboard type, and not to exceed 5’ – 4” (1.6m) above finished floor.

.5 Ammeters shall be thermal demand and instantaneous analogue indicating type, minimum 250 degree full scale. Provide 3 ammeters for each of the buses ‘A’ and ‘B’.

.6 Voltmeter shall be switchboard type, analogue indicating type, and minimum 250 degree full scale c/w 4 position voltmeter switch (off – A – B – C ).

.7 The totalizing type kilowatt-hour and kW demand meter shall be polyphase type, with indicating demand register, connected to measure the total consumption and demand with currents derived from the metering current transformers on Buses "A" and "B".

.8 Digital meters are acceptable. Refer to Section 16426.6 (Metering) for requirements.

.9 Relays shall be semi-flush mounted, drawout type, with built-in test facilities and targets to indicate operation. Relay contacts shall be self-aligning and shall be visible to permit ready inspection.

.10 Phase overcurrent relays (device 50/51) shall be induction type, moderately inverse time characteristic with instantaneous element with tap ranges 4-12 amp inverse time and 20-80 amps instantaneous.

.11 Residual overcurrent relays (device 50/51N) shall be induction type, moderately inverse time characteristic with instantaneous element with tap ranges 0.5-2.5 amp inverse time and 4-16 amp instantaneous.

.12 The sending and receiving pilot wire relay (device 87) shall match the existing loop relays. Verify with the owner the existing sending and receiving type relay manufacture and type. Where it is not possible to match the new switchgear relays with the existing pilot wire relays, supply and install a new sending and receiving relay c/w associated check relays in the owners existing switchgear in order to match the new switchgear relays.

.13 Relay tap ranges shall correspond with the co-ordination study.
.14 Digital and electronic relays with equal or better functionality may be accepted. Submit detailed specification to U of T Project Manager for approval.

16346.6 Instrument Transformers

.1 Provide all necessary instrument transformers to operate the metering and relaying.

.2 Current transformers shall have ratios as indicated. They shall have withstood rating equal to the momentary rating of the circuit breakers. They shall be insulated for the full voltage rating of the switchgear. Metering CTs shall be revenue grade (0.3% accuracy). Relaying accuracy shall be provided for all relaying CTs.

.3 Separate sets of current transformers (3 CTs per set) for each of Bus A and Bus B shall be provided for each of the following: 1) one set for metering; 2) one set for overcurrent relaying; 3) one set for pilot wire relaying.

.4 One set of potential transformers configured for 120/240 Volt secondary rating shall be provided, drawout type, protected by S&C fused fault limiters type FFL-1 or GE current limiting fuses Type EJ-1B on both the primary and secondary windings. Transformers shall be kVA rated to provide switchgear metering requirements and 120 Volt station battery supply requirements.

.5 All current circuits shall be provided with dead front shorting type test blocks located on the front of the switchgear.

.6 Any auxiliary devices needed to complete the meter, relay and instrument equipment shall be included as required.

16346.7 Accessories

.1 Nameplates, engraved lamacoid, with black letters on white background, fastened with stainless steel screws.

.2 Nameplates for the cell doors and switchboard designation shall have letters minimum 25 mm high. Nameplates for meters, relays, test blocks, indicating lights and controls shall have letters 6 mm high.

.3 Nameplate engraving requirements will be marked by the Owner on the shop drawings.

.4 Suitable warning nameplates, with white letters on red background on the front and back of each cell door and hinged panel having access to HV equipment. Name plates shall be fastened using stainless steel screws.

.5 Mimic bus, installed on the front of the switchgear clearly identifying the internal electrical arrangement of the equipment in each cell. The mimic bus shall be securely fastened using stainless steel screws. Mimic bus shall show all devices in white.
on red background, including but not limited to circuit breakers, loadbreak switches, fuses, PTs, CTs, and grounding points.

.6 Breaker test plug and control power source for testing breakers outside of the switchgear and mounted in a separate EEMAC I wall-mounted enclosure, suitable for operating from 120 Volt, 60 Hz, single phase supply.

.7 Control jumper for testing breaker in disconnected position.

.8 Hand crank for withdrawing breakers into the test and fully disconnected positions.

.9 Complete set of non standard tools as required, and one insulated HV hook stick for HV fuse holder removal.

.10 Tow bar if required for manoeuvring truck mounted breaker outside of cell.

.11 One dozen spare LED type indicating lamps.

16346.8 **13.8 kV Load Break Switches**

.1 Loadbreak switches shall comply with CSA Standard C22.2 No. 193 and shall be of the loadbreak interrupter type, quick make, quick break, group operated, with chain coupled mechanism and operating handle on the front of the cell. Provision shall be made for padlocking the operating mechanism with the switch in the open or closed position, with positions clearly labelled. Interrupters shall be rated:
- 600 Amps rms continuous
- 600 Amps rms interrupting
- 40 kA rms asym momentary,
- 40 kA rms asym fault closing
- 25 kA rms sym 2 sec current

.2 Switches shall be of North American manufacture.

.3 Switches shall be 3 pole group operated by a handle mounted external to the switch compartment and arranged such that operating the switch does not require the operator to stand directly in front of the cell door.

.4 Switches shall have all required phase to phase and phase to ground barriers, with horizontal barrier between switch and fuses and between switch and potential transformers. Barriers shall be white flame retardant insulating material complying with NEMA requirements for grade GPO-3 and shall be minimum 5mm thick.

.5 Switch contacts shall be silver plated.
.6 Chain operated switches shall have chain guard designed to prevent contact of chain with live parts in the event of chain failure.

.7 Fusible switches shall be provided with fuse holders and fuses, and 3 spare fuse refill units. Fuse holders shall be S&C Electric Disconnect Style or approved equal, disengaged from the closed to open position by use of an insulated hook stick, and shall not require any other tool to disengage. In the open position, fuse holders shall be capable of being manually lifted out of the switch assembly without use of any special tools. Similar reinstallation requirements shall apply.

.8 Fuses shall be non-deteriorating, refillable power type, type SM-5S, as manufactured by S & C Electric Disconnect Style or approved equal, complete with S & C mufflers. Fuses shall have minimum ratings of 14.4 kV, BIL rating of 95 kV, and interrupting capacity of 500 MVA sym, 21 kA rms sym, and 33.6 kA rms sym. Fuse ratings shall be as shown on the drawings or as specified later.

.9 Switches shall be installed at the top of each cell and fuses at the bottom. Inverted switches shall not be used.

.10 Voltage indicators shall be provided, one per phase for all three phases, on load side of each switch and shall be visible through the viewing windows. Voltage indicators shall be TEDC YZ-2 as supplied by THIES Electrical Distributing Co. of Cambridge, Ontario or approved equivalent.

.11 Three spare fuse refill units shall be provided for each fused switch in a suitable holder mounted on the back of the cell door giving access to the fused switch.

.12 Hinged safety screens painted black shall be installed in front of the interrupter units and all live parts, with padlock provision. The hinged safety screen shall be mechanically interlocked with the cell door to prevent closing the cell door with the hinged panel unsecured. The fuse and PT compartments shall be inaccessible, except when the switch is in the open position.

.13 Viewing windows shall be provided for visual inspection of each switchblade position and each voltage indicator. Viewing windows shall be 13mm Lexan clear polycarbonate bolted to the inside of the door with minimum 13mm overlap with gasket in between. Viewing windows shall not restrict infrared scanning of the switchblades through the windows with the switch in the closed position.

.14 Grounding studs shall be provided on the load side of each switch, one per phase, ball type c/w insulating boots requiring a hook stick for removal. With the insulating boots removed, the spacing between grounding studs shall not reduce the spacing requirements between phases. Grounding stirrups are also acceptable.
.15 Each fused load break switch shall be provided with a Kirk key interlock where the switch supplies a dry type transformer having hinged access doors to HV components within the transformer enclosure. The switch must be in the open position to release the Kirk key to enable opening the Kirk key interlock on the transformer. Co-ordinate keying with the transformer manufacturer.

.16 Switches shall be provided with operations counter.

16346.9 **13.8 kV Circuit Breakers**

.1 Circuit breakers shall be horizontal truck mounted drawout, air magnetic, SF6 or vacuum type, 3 pole, single throw, electrically operated, trip free, with self-aligning disconnecting contacts for power and control. Circuit breakers shall be of one type and readily interchangeable with other circuit breakers in the switchgear.

.2 Circuit breakers shall have the following minimum ratings:
   - 13.8 kV nominal, 15 kV maximum design;
   - 1200 Amps continuous current rating;
   - 500 MVA sym interrupting capacity;
   - 36 kV power frequency withstand voltage;
   - 95 kV BIL;
   - 3 kA rms sym max interrupting;
   - 3 kA rms sym 3 second short time current;
   - 37 kA rms asym closing and latching;
   - 5 Hz rated interrupting time;
   - Operating duty CO-15 second-CO;
   - Control voltage rating 125 VDC nominal, 90-140 VDC closing, 70-140 VDC tripping.

.3 Circuit breakers shall be of North American manufacture.

.4 Breakers shall be withdrawable to "test" and "fully disconnected" positions. Self-aligning disconnecting contacts shall be provided for power and controls. Primary disconnecting contacts shall automatically engage in the operating or fully connected position, and secondary contacts shall automatically engage in the operating and test positions.

.5 Air circuit breakers shall have efficient non asbestos arc extinguishing devices with blowout coils to produce transverse flux during interruption of the circuit.

.6 Breakers shall be operated by a stored energy mechanism which is normally charged by a DC motor, but which can also be charged by a manual handle for emergency closing or testing.
.7 The closing speed of the contacts shall be independent of both control voltage and the operator. Interrupting time shall be uniform, and shall not exceed 5 Hz.

.8 Air circuit breaker movable contacts shall be mounted so that they are easily accessible for inspection. SF6 and vacuum type circuit breakers shall be provided with readily readable contact wear indicators.

.9 Each circuit breaker shall have two type "a" and two type "b" auxiliary contacts wired out to a terminal strip in the cell front upper compartment.

.10 Breakers shall have a hand crank means for horizontal racking into the fully connected and out to the test and fully disconnected positions. Provision shall be made for padlocking the breaker in the fully disconnected and test positions. Operating personnel shall not have to enter the breaker compartment to rack out the breaker to the test and fully disconnected positions. The cell door must be capable of being closed with the breaker in fully disconnected position.

.11 The breaker control voltage shall be nominal 125 Volts DC.

.12 Breakers of the same rating shall be interchangeable.

.13 Circuit breaker cells shall match the fused switch cells in general appearance.

.14 Automatic shutters shall separate all HV circuit breaker contacts from the breaker compartment when the breaker is in the test and fully disconnected positions.

.15 Mechanical interlocks shall ensure that a breaker is open before it can be racked into or out of the "connected" position, and to prevent closing a breaker unless it is in the "fully connected", "fully disconnected" or "test" positions.

.16 A mechanical position indicator shall be provided at the front of each breaker cell to indicate the racked position of the circuit breaker.

.17 Sliding ground contact shall be provided to ensure that breaker frames are grounded before the primary or control disconnecting contacts are made.
16346.10 **Typical Switchgear Configuration for a Building Double Ended (2 Power Transformers T1 and T2) Substation Switchgear Based on HV Cable Top Entry and Connected into the U of T 13.8 kV Loop System**

The following shall be included in each cell:

1. **Cells #1 and # 8**
   - 1 fused load break interrupter switch in Cells # 1 and # 8 for supply of transformers T1 and T2 respectively. Each cell c/w voltage indicators and grounding studs.

2. **Cells #2 and # 7 (Transition)**
   - 3 current transformers, revenue metering accuracy, 1200/5 Amps, wired to Cell #4 to the respective CT shorting type test block for ammeters and totalizing kW-hour and demand meter on front of Cell #4.

3. **Cell #3 (Incoming Circuit Breaker for Bus A)**
   - **Cell #3 Front Door of Upper Compartment**
     - 3 phase induction overcurrent relays, 50/51;
     - 1 residual induction overcurrent relay, 50/51N;
     - 1 pilot wire check relay 85 and pilot wire sending relay 87;
     - 1 circuit breaker control switch;
     - 5 LED type indicating lights: red "closed", green "open", white "fault trip", white "transformer gas trip" and white "transformer over temperature trip";
     - LED type indicating light, white for low SF6 pressure where SF6 type circuit breaker is supplied;
     - Push to test lamp test switch to test integrity of all indicating lamps on this door;
     - Dead front shorting type current transformer test blocks for relays on this door, wired to relays and to respective current transformers in the lower rear compartment of this cell;
     - Wire out all protective relay trip contacts, pilot wire relay non CT wiring, breaker control switch, and all indicating LEDs and LED push-to-test switch to terminal block(s) in the inside upper compartment of this cell.

4. **Cell #3 Inside Upper Compartment**
   - This compartment shall contain all terminal blocks and auxiliary relays for wiring interconnections between all relaying and control and LED annunciation and test devices on the front door of this compartment, and wiring and auxiliary relays for the trip and control circuits of this cell circuit breaker;
- This compartment shall contain a 2 pole knife switch and deadfront DC fuse holder c/w fuses and all wiring and connections to this cell circuit breaker control circuit. DC supply wiring shall be provided from the switch to the station battery supply terminal block in Cell #4;

- This compartment shall contain a 2 pole knife switch and deadfront DC fuse holder c/w dummy fuses and all wiring and connections to this cell circuit breaker trip circuit. DC supply wiring shall be provided from the switch to the station battery supply terminal block in Cell #4;

- This compartment shall have a terminal block from which shall be connected all non CT pilot wire relay wiring between the pilot wire relays on the front door of this compartment and the pilot wire relay terminal block in Cell #4;

- This compartment shall have a terminal block with wiring from the trip circuit of this cell circuit breaker to the terminal block, and wired to the remote transformer T1 sudden gas trip contacts and over temperature trip contacts connected to the remote alarm terminal block in Cell #4;

- This compartment shall contain auxiliary DC relays wired into the trip circuit of this cell circuit breaker and connected to the terminal block provided for incoming remote transformer T1 sudden gas and over temperature trip contacts. Wire to trip and annunciate this cell circuit breaker and wire to Cell #4 circuit breaker trip circuit to trip breaker. Wire a set of auxiliary relay contacts to the remote alarm terminal block in Cell #4 for remote alarm indication to separately indicate transformer T1 sudden gas trip and transformer over temperature trip;

- This compartment shall contain an auxiliary DC relay wired into the trip circuit of this cell circuit breaker, wired to pickup when trip is initiated by this cell protective overcurrent or pilot wire relaying. Wire a set of contacts via a terminal block in this compartment to the remote alarm terminal block in Cell #4 for remote alarm indication;

- This compartment shall contain an auxiliary DC relay wired into the SF6 low pressure alarm circuit. Wire a set of contacts to the remote alarm terminal block in Cell #4 for remote alarm indication;

- This compartment shall have a circuit breaker type `a’ contact wired from a terminal block in this cell to the remote alarm terminal strip in Cell #4.

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.6 **Cell #3 Upper Rear Compartment**
- Termination for incoming HV cables

.7 **Cell #3 Lower Rear Compartment**
- Incoming and outgoing HV bus and HV bus terminations for circuit breaker. Provide a grounding ball type stud on the circuit breaker load side of each phase c/w insulating boot for maintenance grounding. Where this is not possible, provide in adjoining transition cell;
- 3 current transformers, relaying accuracy, 1200-5 amps, mounted on the line side of the breaker, wired to shorting type test block and overcurrent relaying on door of upper front compartment;
- 3 current transformers, relaying accuracy, 1200-5 amps, mounted on the load side of the breaker, wired to shorting type test block and pilot wire relay on door of upper front compartment.

.8 **Cell # 5**
- Bus transition cell from tie breaker to load side of incoming circuit breaker feeding Bus B.

.9 **Cell #6 (Incoming Circuit Breaker for Bus B)**
- This cell shall be identical to Cell #3 with the exception of the pilot wire relay 87, which shall be a receiving relay and the transformer being T2.

.10 **Cell #4 (Tie Breaker)**

**Cell #4 Front Door of Upper Compartment**
- 6 ammeters, for measurement of Bus "A" and Bus "B" currents (3 per bus) including CT connections to the CT test blocks on this door;
- 1 voltmeter;
- 1 voltmeter switch, 4 position, for measurement of line voltages;
- 1 totalizing kilowatt-hour and demand meter with CT connections to the CT test blocks on this door;
- 2 current transformer test and shorting type test blocks for the metering (one set for Bus A and one set for Bus B) including connections to the metering current transformers in Cell # 2 and Cell # 7;
- 1 circuit breaker control switch;
- 3 LED type indicating lights, red "closed," green "open" and white “fault trip”;
- LED type indicating light, white for low SF6 pressure where SF6 type circuit breaker is supplied;
- Push-to-test lamp test switch to test integrity of all indicating lamps on this door.

.11 Cell #4 Inside Upper Compartment

- This compartment shall contain all terminal blocks and auxiliary relays and wiring for interconnections between:
  - This cell circuit breaker control switch and LED lamps & LED test switch on front of door and this breaker close and trip and alarm circuits; and
  - Kilowatt hour and demand meter on front of door and PT deadfront fuse holders in this compartment.

- This compartment shall contain a 2 pole knife switch and deadfront DC fuse holder c/w fuses, and all wiring and connections to this cell circuit breaker control circuit. DC supply wiring shall be provided from the switch to the station battery supply terminal block in this compartment.

- This compartment shall contain a 2 pole knife switch and deadfront DC fuse holder c/w dummy fuses and all wiring and connections to this cell circuit breaker trip circuit. DC supply wiring shall be provided from the switch to the station battery supply terminal block in this compartment.

- This compartment shall contain a DC station battery supply terminal block with wiring from this block to the 2 pole knife switches in this compartment and to the upper compartment 2 pole knife switches in Cell #3 and Cell #6 for respective circuit breaker close and trip circuit supply. This terminal block shall have provision for terminating incoming 125 Volt DC supply from the remote Station Battery Supply power source.

- This compartment shall contain a pilot wire relay terminal block for termination of two incoming sets of 6 pair pilot wire cables, and connection of pilot wires to terminal blocks in Cell #3 and Cell #6.

- This compartment shall contain a PT isolating switch and deadfront fuse holder and connection to the voltmeter and voltmeter switch on the front door, and deadfront fuse holder and connection to the KWhr and Demand meter on the front door.

- This compartment shall contain a remote alarm terminal block with connections from the auxiliary relay trip alarm contacts in Cells #3 and #6 for remote trip indication, connection provision for each transformer sudden gas and over temperature trip contacts with wiring to respective Cell #3 and Cell #6 trip circuits, connection provision for each transformer
low liquid level alarm contacts for remote alarm indication, connection provision for each transformer sudden gas alarm contacts for remote alarm indication, connection provision for each transformer high temperature winding alarm contacts for remote alarm indication, connection provision from station battery supply common alarm form ‘c’ contacts for remote alarm indication, connection from Cell #3, #4 and Cell #6 circuit breaker low SF6 pressure auxiliary relay alarm contacts for remote alarm indication.

- This compartment shall contain an auxiliary DC alarm relay wired into the SF6 low pressure alarm circuit. Wire a set of contacts to the remote alarm terminal block in this compartment for remote alarm indication.

.12 Cell #4 Lower Compartment
- 1 circuit breaker, identical to incoming circuit breakers in Cell #3 and Cell #6.

.13 Cell #9 (Potential Transformers)
- 1 non-fusible, load break interrupter switch.
- 2 potential transformers, each rated 14400-120 Volts, with each secondary connected 120 Volts to ground, metering accuracy, primary and secondary fusing, for supply of metering and remote Station Battery Supply requirements, and including 2 spare sets of fuses.
- All PT wiring to Cell #4: PT’s shall be readily accessible fused drawout type and shall permit safe fuse replacement. Provide all horizontal and vertical barriers between the PT compartment and the load break switch.

16346.11 Switchgear Control Power Source (Station Battery Supply)

.1 The power source shall be 120 Volt AC input, nominal 125 Volt DC output, in a free-standing, minimum #14 MSG, free standing sprinkler proof reinforced formed steel cabinet, housing batteries, charger, controls and alarms. Provide an internal transfer switch for the AC power source, suitable for switching from the preferred source (switchgear PTs) to the substation emergency AC (backup) power source in the event of failure of preferred source. Transfer switch shall be CSA approved for transfer duty. Transfer switch shall have adjustable 0-60 second transfer from preferred source to standby source and 0-60 second transfer from standby source to preferred source. Provide LED type indicating lights c/w push to test lamp test switch on front of cabinet to indicate which power source is supplying the charger. Provide a power source transfer alarm contact for connection to switchgear.
.2 Two lifting eyes shall be provided. All interior and exterior surfaces shall factory finished white enamel interior and ANSI 61 grey exterior.

.3 Batteries shall be mounted in the lower compartment, on welded angle iron steel supports, stepped to ensure that electrolyte levels of all cells are clearly visible. Two doors shall be provided, complete with 3 point latch and provision for padlocking.

.4 Batteries shall be arranged for easy access and maintenance.

.5 Station batteries shall be ventilated by an exhaust fan leading the exhaust air to the outside of the building. Exhaust under the door is not acceptable.

.6 The battery bank shall consist of single nickel-cadmium cell units, 125 Volts DC output, to operate the closing, tripping and spring charging mechanisms of the HV switchgear circuit breakers, indicating lights and relays. Maintenance-free sealed type lead acid batteries of the same rating are acceptable.

.7 The battery capacity shall be such that after 24 hours operation without the charger, operating two simultaneous trippings followed by two consecutive closings of all 13.8 kV circuit breakers, the output voltage shall not be lower than 105 Volts.

.8 The battery shall be capable of supplying the loads to an end voltage of 1.14 Volts per cell at 25°C.

.9 The battery containers shall be made of polypropylene, complete with flame arrester caps. Maximum and minimum electrolyte levels shall be indicated on the cell jars.

.10 The charger shall be self-regulating, current limited, automatic dual rate, with indicating, control and protective devices. The charger and its controls shall be such that the charging rate decreases as the battery approaches full charge and provides a trickle charge to maintain the battery at fully charged state.

.11 The charger shall be removable without removing the control and power harnesses.

.12 Provide the following:
   - AC input breaker, 1 pole;
   - DC breaker for battery power output, 2 pole DC breaker for charger output;
   - DC charge rate ammeter and output voltmeter, 2% accuracy;
   - 28 day equalize timer;
   - float-equalize switch;
   - float and equalize adjustments independent of each other;
   - lockable;
   - LED type "AC on" lamp.
.13 Provide the following alarms, each with visual LED type lamp annunciation on the charger control panel: Each alarm shall be sealed in through a latching relay or equal means of seal in, with a manual reset switch (common reset switch for all alarms is acceptable).
   - AC failure with a 0 to 60 second adjustable time delay on pickup;
   - High or low output voltage;
   - Rectifier failure;
   - Ground fault (5 mA sensitivity).

.14 Provide a lamp test pushbutton and associated circuitry for testing all LED indicating lamps.

.15 Provide one common alarm form “c” contact for remote indication of all alarms, wired to a terminal block for connection of external wiring to the main switchgear.

.16 All control and power cables shall be neatly laid in conduit duct. Harnesses to the door control panel shall be neatly bundled and suitably tie wrapped, to achieve maximum reliability and enhance the overall appearance. All control and alarm cards shall be of the plug-in type.

.17 Wiring and terminal blocks shall be as specified for the switchgear.

.18 Provide the following battery accessories:
   - Hydrometer;
   - Plastic filler bottle;
   - Insulated wrench;
   - Instructions, including WHMIS MSDS;
   - All necessary intercell connectors;
   - Komoline non-corrosive grease.

16346.12 Substation and Installation Requirements

.1 Means of egress shall be minimum two exit doors at opposite ends of the substation. The 2 exit doors must be at least three quarters (3/4) of the length of the diagonal distance of the room from each other, with one exit door exiting directly to outside the building and via a dedicated staircase where the substation is below grade. The door exiting to the exterior of the building and associated staircase shall be of sufficient height and width to enable removal of the largest piece of substation equipment. Exit doors shall be fitted with panic type hardware on the substation side and fitted with a keyed cylinder and handle on the opposite side of the door. Type of cylinder and keying, and type of panic hardware will be specified by U of T (check with lock shop). Access to Electrical room shall not be through janitor rooms or
washrooms.

.2 Ventilation for the substation shall be dedicated to the substation only. Provide filtered supply air in quantities as required by Code and taking into account the heat build up from transformer losses. Dampers shall be electrically operated with local temperature control within the substation. Fans, filters and dampers and associated controls shall be readily accessible within the substation and shall not require standing on or leaning on or over any electrical equipment to maintain, and shall be accessible using only a step ladder. Substation ventilation shall be designed to maintain a positive pressure within the substation. Ventilation power supply and control shall be from the substation emergency supply panelboard and on-off-auto control shall be within the substation (fan starters). Provide automatic closing fire dampers for ventilation openings to the indoors of the building.

.3 Provide dehumidification in the substation. Dehumidification shall be dedicated to the substation and all dehumidification equipment and controls shall be within the substation. Dehumidification equipment and associated controls shall be readily accessible within the substation and shall not require standing on or leaning on or over any electrical equipment to maintain, and shall be accessible using only a step ladder. Dehumidification power supply and control shall be from the substation emergency supply panelboard.

.4 Substation heating shall comply with applicable Codes and shall consist of unit heaters with integral fans, wall mounted or ceiling hung, with wall mounted control thermostat. Heaters and associated controls shall be readily accessible within the substation and shall not require standing on or leaning on or over any electrical equipment to maintain, and shall be accessible using only a stepladder. Heaters shall be electric and shall be supplied from the substation emergency supply panelboard.

.5 Provide a high temp low temp room thermostat with alarm contacts for remote alarming of high and low temp substation condition.

.6 Adequate substation drainage shall be provided. Where the substation is sprinklered, floor drains shall be provided with capacity to prevent flooding in the substation when all sprinkler heads are operating. Each drain shall be provided with a backflow preventer. Each drain shall also be provided with self priming.

.7 Provide housekeeping pads for all high and low voltage switchgear, station battery supply, and any other floor mounted equipment. Install switchgear manufacturer’s floor channels in the switchgear concrete pads. Height of the concrete pads shall not be less than 4 inches above finished substation floor.
.8 Provide concrete ramp in front of each high voltage switchgear circuit breaker cell sloped per switchgear manufacturer’s recommendation to allow removing truck mounted circuit breaker from the cell to the substation floor. Ramps shall be painted yellow.

.9 Provide concrete cast-in-place dyke around each liquid filled transformer in the substation, with perimeter and height of dyke sized to contain the total liquid volume of the transformer in the event of a transformer leak. Waterproofing of the contained area and dykes shall be non-conductive and compatible with the transformer liquid.

.10 Provide a dry sump pit c/w pump, float and alarm switch connected back to CCMS. Sump pump shall be supplied by emergency power.

.11 The substation concrete floor and all switchgear, switchboard, station battery power supply cabinet, and other equipment concrete housekeeping pads and concrete ramps shall be completely sealed and finished with an epoxy based high wear non-conductive concrete finish, minimum two coats or as otherwise recommended by the manufacturer.

.12 The substation ceiling height shall be such as to allow for high voltage cable entry into the top of the high voltage switchgear using recommended bending radius, based on the cable being 750kcmil 3 conductor 15kV XLPE, with the horizontal run suspended 0.5 meter below the ceiling.

.13 Provide clearances around high and low voltage equipment as required by Code. Code requirements are minimums and in certain situations clearances should be increased. Special attention shall be paid to the following: clearance in front of the high voltage switchgear shall provide adequate clearance to permit the removal of the circuit breakers and maneuvering them to the breaker test plug facility; clearance behind the high voltage switchboard shall allow for 1 meter clearance between the wall (or other obstruction) and the widest rear cell door when that door is at the 90 degree open position.
.14 Lighting for the substation shall be fluorescent, industrial type 4-foot long fixtures, c/w electronic 120 Volt ballasts and 32 watt T8 or T5HO lamps. Lighting shall provide a minimum lighting level of 70 Foot-Candle at floor level in front of, to the sides of and behind all electrical equipment. Placement of lighting fixtures shall allow easy access for lamp replacement, accessible only by stepladder and not requiring standing on nor leaning on or over electrical equipment. One half of the substation lighting shall be on normal building supply and one half supplied from the substation emergency supply panelboard. Lighting shall be controlled from illuminated light switches located on the substation latch side of the exit doors. Lighting in the substation dedicated staircase where staircase is required shall be supplied from the substation emergency supply panelboard.

.15 Wall mounted battery operated self contained emergency lighting units of the battery rechargeable type shall be provided and plugged into emergency receptacles supplied from the substation emergency supply panelboard. Provide the required number of lighting units to illuminate all aisle ways and exits and dedicated staircase to exterior of building in the event of a power failure.

.16 Illuminated LED type exit signs shall be installed over exit doors and shall be supplied from the substation emergency supply panelboard.

.17 Provide duplex receptacle outlets around the perimeter of the substation spaced as required by Code but in no case more than 12 feet apart. Outlets shall be mounted in type FS outlet boxes with matching steel cover plates. One half of the total outlets shall be supplied from the substation normal supply panelboard and one half from the substation emergency supply panelboard. Outlets shall be circuited such that a minimum of two circuits supply all outlets and no two adjacent outlets are on the same circuit. Receptacles supplied from emergency power source shall be red.

.18 Provide a substation normal supply panelboard rated 120/208 Volt ac, 3 phase, 4 wires, with copper mains rated as required but no less than 100 Amps. Panelboard shall be supplied from the building main low voltage switchboard. Panelboard shall be surface mounting type, sprinkler proof construction, c/w main bolt-on circuit breaker and bolt-on branch circuit breakers sized as required to supply the substation non-emergency lighting and receptacles.
.19 Provide a substation emergency supply panelboard rated 120/208 Volt ac, 3 ph, 4 wires, with copper mains rated as required but no less than 100 Amps. Panelboard shall be supplied from the building emergency generator main emergency supply distribution panelboard. Panelboard shall be surface mounting type, sprinkler proof construction, c/w main bolt- on circuit breaker and bolt-on branch circuit breakers sized as required to supply the following:

- Substation Battery Power Supply for switchgear
- Substation ventilation
- Substation heating
- Substation lighting (minimum 2 circuits)
- Substation battery emergency lighting units receptacles
- Substation exit lighting
- Substation perimeter receptacles (minimum 2 circuits)
- 13.8 kV Circuit Breaker Test Plug

.20 All low voltage conduit and wiring in the substation shall comply with the U of T requirements for same. Special attention shall be made to the termination of conduits entering the tops of sprinkler proof equipment so as to not defeat the sprinkler proofing.

.21 Provide non ferrous cable tray for the support of all HV cables in the substation and ground as required.

.22 Provide cable pulling eyes cast into the walls of the substation for pulling incoming HV cables into the substation.

.23 Provide substation perimeter copper bus grounding system and all high and low voltage equipment grounding to same as required by the Ontario Electrical Safety Code.

.24 Provide all conduit and wiring from the transformer control panels and station battery supply cabinet to Cell #4 in the high voltage switchgear for termination of all alarm and trip wiring on to remote alarm terminal block in upper compartment.

.25 Provide all conduit and remote alarm wiring from the remote alarm terminal strip in the HV switchgear Cell #4 upper compartment to a U of T supplied Remote Alarm Control Panel mounted on the wall next to the HV switchgear.

.26 Provide all conduits and alarm wiring from the dry sump float alarm contact to a U of T supplied Remote Alarm Control Panel.

.27 Provide all conduits and wiring from the substation alarm high temp low temp thermostat to the U of T supplied Remote Alarm Control Panel.
.28 Install the 13.8 kV circuit breaker test plug on a wall near the HV switchgear and with sufficient and level floor area for moving around and testing the circuit breaker. The test plug shall be wired to the substation emergency supply panelboard.

.29 Provide a substation combined single line diagram and substation equipment block diagram for the substation. Size of the diagram shall be minimum Size D and shall be installed under non glare glass with UV inhibitor, and framed in wood. The framed diagram shall be securely fastened to a wall of the substation near the HV switchgear.

.30 Set and secure all equipment in place on the housekeeping pads or floor where pads are not required, plumb and square. Connect all equipment at the shipping splits, using the manufacturer’s hardware and torque to the manufacturer’s recommendations. Ensure all sprinkler proofing is in place and properly installed. No foreign pipes shall be allowed to pass through the substation.

.31 After installation and levelling, all switchgear, switchboards and other equipment shall be caulked to prevent bottom entry of vermin.

.32 Install a minimum 1” thick plywood backboard on a wall close to the HV switchgear for mounting all tools necessary for the safe maintenance and testing of the HV switchgear. Board shall be primed and painted with minimum two coats of high quality enamel paint, grey.

.33 Check factory-made connections for mechanical security, electrical continuity and current phasing.

.34 After finishing work, remove foreign material, including dust, and thoroughly clean the switch gear before energizing equipment.

.35 Electrical room space shall not be shared with communication equipment, such as telephone, data, server, router or hub. Provide separate room for communication equipment.

.36 Door sweeps shall be installed on the bottom of all HV Substation and electrical rooms.
16346.13  **Testing**

.1  After installation is complete, but prior to energizing, test all mechanical and electrical components for proper operation and function in accordance with the manufacturer's recommendations, including but not limited to the following:

.1  Perform resistance measurements on bus, phase-to-phase and phase-to-ground with all switches and breakers in the normal operating position, with the contacts open.

.2  Measure control circuit insulation resistance to ground.

.3  Employ the service of an independent testing company to inspect all protective relays and overcurrent devices, and verify or reset the settings to comply with the coordination study.

.4  Inspect all current transformers and relays for correct polarity connections and installation of jumpers in unused current transformer circuits.

.5  Make logic check of the controls and interlocks, simulating operating and fault conditions.

.6  Check that all ground connections have been securely made.

.7  Manually close and trip each breaker and close and open each load break switch and adjust main contact alignment and wiping action in accordance with the manufacturer's instructions.

16426  **Low Voltage Distribution System Equipment (600 Volts Maximum)**

16426.1  **Main Switchboard**

.1  The main switchboard shall be a complete, metal enclosed, factory assembly, tested and shipped ready for installation.

.2  The switchboard shall comply with the applicable standards of CSA, ANSI, EEMAC and NEMA.

.3  The voltage, current and short circuit rating of the switchboard shall be discussed with the U of T Project Manager.

.4  Provide Arc Flash calculations and Arc Flash warning labels on switchboard front panel.

.5  The switchboard shall be of the size and number of sections indicated, and shall not exceed the dimensions shown on the drawings or specified.
.6 The entire switchboard shall be shipped in one section unless written approval is given by the U of T Project Manager. Field connections of bus work shall be limited to reconnection of these sections with factory predrilled and prefabricated components.

16426.2 Construction

.1 The enclosure shall be sprinkler proof, made up of steel frames bolted and welded together to form a rigid, free-standing, dead front structure. All sections shall be of uniform dimension and appearance.

.2 Front panels or doors shall be formed type, fabricated from cold rolled sheet steel and supported by concealed hinges. Flat, bolt-on panels shall be supplied on the top and on the sides. Hinged doors shall be provided at the rear of the assembly.

.3 Each cubicle shall be divided vertically into two sections. The front section shall be further divided by sheet steel barriers into compartments containing instrument transformers, circuit breakers, fused switches and other equipment. The rear section shall include buses and provision for connecting external wiring entering from the top or bottom as required.

.4 Circuit breaker compartments shall be equipped with primary and secondary disconnecting contacts, breaker mounting pan complete with integral rails, instrument transformers, stationary disconnecting mechanism parts and a mechanical interlock which prevents moving the removable unit into or out of the connected position while the circuit breaker is closed.

.5 Compartments for future breakers shall be complete with bus connections, disconnecting contacts and supporting rails, ready for the insertion of a breaker and with insulating covers for the disconnecting contacts.

.6 The structure shall be mounted on a channel base supplied by the manufacturer. The structure shall be suitable for lifting from a truck and being rolled and jacked into position.

.7 Hardware shall be steel with non-corroding plating.

.8 The switchboard shall be factory finished white enamel interior, ANSI 61 grey exterior.

.9 Provision shall be made for cables and/or bus ducts entering the top of the switchgear.

16426.3 Buses

.1 Buses shall be high strength, high conductivity, tin plated copper. Provision shall be made for extending the buses to future cubicles at each end of the switchboard.
.2 Buses and connections shall be designed so that the maximum temperature rise of any part will not exceed 65°C in an ambient temperature of 40°C.

.3 Buses shall be joined together with a minimum of two bolted connections. Bus joint hardware shall be non-corroding.

.4 A continuous copper ground bus shall be run near the bottom, the full length of the switchboard. The metal frames of all components shall be connected to the ground bus. Provide a lug for connecting to the external ground conductors at each end of the bus.

.5 The momentary rating of the ground bus shall be equal to or greater than that of the apparatus in the assembly. The minimum size shall be 7 mm x 50 mm.

.6 Provide bus transition sections where required, with bolted access panels.

16426.4 Circuit Breakers

.1 Air circuit breakers shall be 3 pole, single-throw, 60 Hz, quick make, quick break, trip free, electrically-operated, spring-closed, stored energy type, complete with three adjustable solid state series overcurrent tripping devices, arc chutes, position indicator and mechanical trip button.

.2 Breakers shall be equipped with a grounding device to solidly ground the framework before the main disconnecting contacts are engaged and to maintain the grounding until after the contacts have separated.

.3 Breakers shall be capable of withdrawal from the "connected" to the "test" and "disconnected" positions with the cubicle door closed. Each breaker shall be equipped with a position indicator, mechanically connected to the circuit breaker mechanism. Interlocks shall be provided to prevent moving a closed breaker into or out of the "connected" position.

.4 Circuit interrupting devices shall have high interrupting efficiency and shall minimize the formation of arc flame and gases.

.5 Breakers shall have ground fault interrupting devices.

.6 Circuit breakers shall give visual indication of the reason for tripping. Trip indicators shall be maintained type which remain in position until manually reset and which operate without an external power supply.

.7 The air circuit breakers shall have silver-tungsten, butt type contacts which operate under high pressure. The arcing contacts shall be of arc-resisting silver-tungsten. The breaker shall be equipped with arc chutes which effectively enclose the arcing contacts and confine the arc to reduce the disturbance caused by short circuit interruption.
.8 The removable element shall consist of an air circuit breaker equipped with the necessary disconnecting contacts, wheels and interlocks for drawout application.

.9 The closing springs shall be capable of being charged manually by means of an emergency handle. The release of the energy to close the breaker manually shall be by means of a mechanical pushbutton which ensures positive control of the closing operation.

.10 Breakers shall have a solid state overcurrent tripping system, consisting of one current sensor per pole, one solid state trip unit and one trip actuator operating on the flux transfer principle. The trip unit shall have continuously adjustable long delay current pick-up, long delay time, short delay current pick-up, short delay time and instantaneous pick-up. Breakers shall be equipped with a ground current pick-up, set at the factory, at a level determined by the coordination study.

.11 Main breakers shall have ground fault protective equipment, including ground fault sensors, current monitors, relays and devices for a complete ground fault protection system. Main incoming circuit breakers and tie circuit breaker shall be equipped with shunt trip to allow for remote connection to a remote trip contact.

.12 All necessary tripping energy shall be derived from the load current and no separate power supply shall be required. All tripping functions on each breaker must be performed by one secondary control circuitry, with no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the breaker. Mechanical tripping of the breaker shall be made by an actuator which will operate the mechanical tripping mechanism of the breaker when a tripping pulse is emitted by the trip unit. When the trip unit does not have an instantaneous element, it shall include a discriminator feature to permit instantaneous tripping only when the breaker is being closed. Breaker trips shall be completely self-powered with no external control power source required.

.13 Each trip unit shall have a terminal block equipped with test plug terminals accessible at the front to permit convenient field checking and calibrations. The tripping current range shall be established by the sensor rating rather than by the trip unit. Necessary tripping energy shall be produced by current sensors installed on each phase which shall produce an output proportional to the load current, so the breaker continuous current rating for any frame size can be changed simply by changing the sensors. Sensors shall be installed on the load side of the breakers and must remain with the breaker when it is withdrawn.

.14 All breakers of the same frame size shall be interchangeable.
16426.5 **CDP Panel Sections**

.1 The ends of the low voltage switchboard shall be provided with a distribution panel section. The voltage, current rating and short circuit rating shall be discussed with the U of T Project Manager.

.2 Provide circuit breakers with current limiting fuses if necessary to meet the short circuit rating.

.3 The panel shall be double row, with maximum number of spaces that height permits, based on the section being the same height as the switchboard.

.4 The panel sections shall have hinged lockable doors and hinged front cover plates to permit inspection by thermal scanning. A directory card holder shall be welded to the back of the door and be complete with card and clear plastic cover with typed directory.

.5 Lamacoid nameplates shall be installed next to each circuit breaker, minimum 6mm high white letters on black background secured with stainless steel screws, identifying the load supplied.

16426.6 **Metering**

.1 Provide sub metering for areas such as food services, tenants, chillers or lab’s with high usage equipment where it would be desirable to separate from the rest of the building. Discuss the requirements with U of T Project Manager.

.2 Provide all necessary current and potential transformers for the Owner's metering and alarms requirements.

.3 Potential transformers shall be primary fused and fuses shall be HRC type, readily accessible. P.T. secondary shall be 120 V.

.4 Current transformers shall have revenue grade (0.3%) metering accuracy and shall be provided with dead front shorting type test blocks. Current transformer secondary shall be 5 Amp. CTs shall be bar type or solid core donut type, split core is not acceptable.

.5 Provide switchboard digital metering of the integrated microprocessor based type, true RMS measurement for the display of the following:

   Energy – kWH, kVARH, kVAH;
   Demand – kW, kVAR, kVA;
   Voltage – Phase voltage, Line voltage;
   Current – Phase current, Line current;
   Frequency;
   Power factor;
   Harmonics – THD for voltages and current.

For demand (kW, kVAR, kVA), voltage, current, frequency, power factor, and harmonics contents, provide instantaneous, maximum and minimum values for each phase and totals for all phases. Show imbalance for voltages and currents. Readings for
each of these parameters shall be separately resettable. For energy contents (kWH, kVARH, kVAH) provide accumulated totals for all phases. The readings for energy parameters shall be non-resettable.

.6 Digital metering shall continuously monitor and store the readings in a non-volatile memory. Should a power interruption to the switchboard occur, the last readings shall be available for display once power is restored.

.7 Digital meters should be backlit LCD type or LED type, suitable for displaying the maximum number of characters required including floating decimal point. Character sizes should be minimum 3/8 inch high with proportional width to provide easy readability.

.8 Reading refresh rate for the digital meter shall be once per second (or faster).

.9 Digital metering accuracy shall be ±0.5% of full range or better, preferably Measurements Canada Revenue approved type.

.10 Digital meters and associated switches shall be flush mounted on the front of the switchboard or in a metering cabinet mounted on the wall with proper identification.

Where the switchboard is divided into Bus “A” and Bus “B” sections separated by a normally open tie circuit breaker, provide a separate digital meter for each bus.

.11 Digital meters shall be capable of remote communication, interface via Modbus TCP/IP protocols, through serial or Ethernet communications.

.12 Digital meters shall be powered from a separate power supply or control power transformer and shall not be powered from the metering PTs.

16426.7 **External Connections**

.1 Provide bus extensions and bus duct flanges as required, completely coordinated to the incoming bus duct feeders. Provide bus transition section where required with bolted access panels.

.2 Bus ducts shall be copper, of current rating and voltage as required and in sprinkler-proof enclosure, complete with all required elbows, terminations, fittings and accessories.

.3 The switchgear manufacturer shall be responsible for proper coordination of the bus duct at the switchgear and transformer ends.

.4 Bus terminations shall be accessible for inspection.

.5 Provide clamp type terminal blocks complete with marking strips for all interconnecting and outgoing small wiring. Terminal blocks
shall be accessible for inspection and testing.

.6 Identify terminals and conductor ends by means of suitable markers, to agree with the wiring diagrams.

.7 Control wiring shall be type TEW thermoplastic equipment wire.

.8 Control wiring shall be run not closer than 150 mm from the bottom of the switchboard.

16426.8 Accessories

.1 Nameplates shall be engraved lamacoid, with white letters on a black background, fastened with stainless steel screws.

.2 Nameplates for main and tie breakers, section and cell identification and for the entire switchboard shall have letters not smaller than 13 mm high. Nameplates for branch breakers, switches, pushbuttons, control devices, pilot lights and metering shall have letters 6mm high.

.3 Warning signs on doors and access panels shall be engraved lamacoid with white letters on a red background, fastened with stainless steel screws.

.4 Pen size for all lettering shall be 1mm (minimum).

.5 Control contacts, auxiliary contacts, relays and small or light mechanisms shall be enclosed and protected, and shall be accessible for repair or adjustment.

.6 Furnish the following accessories:
- set of extension rails;
- hoisting device for removing breakers;
- breaker lifting yokes;
- 1 test plug for each test block;
- levering out device, if required;
- 2 sets of special tools and hardware, for maintenance, removal and handling.

16461 Dry Type Transformers

16461.1 4.16 kV and 13.8 kV Dry Type Power Transformers (Indoor use only)

.1 Transformers shall be power type ANN/ANF indoor, air cooled, dry type with continuous ANN capacity as specified. Transformers shall comply with the latest requirements of ANSI-C57.12.01 and CSA C9.

.2 Transformer enclosures shall be NEMA 2-S, sprinkler proof construction.

.3 Transformer windings shall be copper.
.4 Transformers shall be three phase with Delta primary and Wye secondary, with the wye solidly grounded.  

.5 The insulation shall be Class H, 220 °C, with maximum temperature rise 150°C over 40°C ambient at ANN rating. 

.6 The transformers shall have four 2.5 % full capacity primary taps, two above and two below normal voltage. Provide off load tap changing capability. 

.7 The transformers shall be high efficiency, low impedance type. 

.8 The maximum sound level at ANN rating shall be 68 db for transformers rated up to 3,000 kVA. 

.9 The transformers shall have B.I.L. rating as required for the voltage class, minimum 60 kV for 4.16 kV and minimum 95kV for 13.8 kV. 

.10 The transformers shall be equipped with fans to increase the ANN rating by 33%. 

.11 A sprinkler proof control panel for the transformer forced air cooling supply and control, transformer local audible and visual alarms and auxiliary relays for local and remote trip and alarms, shall be mounted on the exterior of the transformer enclosure. Control panel shall have a hinged access door. Visual alarms shall be LED type annunciation lamps, one per individual alarm, and shall be located on the front door of the control panel. Audible alarm shall be minimum 4” horn mounted on the front of the control panel door, with provision for remote audible alarm. 

.12 The control panel power supply shall be wired from the secondary of the power transformer and shall include necessary transformation to 120 Vac. The control panel shall incorporate main fusing and wiring sized for fan supply requirements, fused control transformer and fans contactor and associated on-off-auto control switch, local and remote alarm horn, and auxiliary relays as required for local and remote alarm requirements. 

.13 The control panel shall include all wiring to the transformer winding temperature thermometer which shall have 3 sets of contacts: 1) fan cooling; 2) high temp alarm; 3) high temp trip. Fan cooling contacts shall initiate fan start-up, high temperature alarm shall initiate local and remote audible alarm and auxiliary relay in control panel for remote alarm, with form ‘c’ set of contacts terminated on a terminal block. High temp trip contact wiring shall terminate on terminal strip in control panel. All alarm relays in the control panel shall be seal-in and an alarm horn silencing switch with ring back feature together with an alarm manual reset switch located in the control panel shall be provided. 

.14 A dial type winding temperature 3 stage thermometer having 3 sets of contacts (fan cooling, high temp alarm, high temp trip) shall be
mounted on exterior of transformer enclosure. Dial thermometer shall have maximum temperature indicator with manual reset.

.15 All wiring shall be provided between the transformer control panel and transformer cooling fans.

.16 Primary terminations shall match type and arrangement of incoming power connections. Potheads, where required, shall be part of transformer. Provide grounding stirrup with sufficient clearance at primary terminations.

.17 Secondary terminations shall match type and arrangement of outgoing bus ducts or cables.

.18 Adequately size junction or throat to accommodate phase connections.

.19 The neutral bushing shall be brought out into junction box and grounded.

.20 Transformers having hinged access doors to the HV compartment shall have Kirk key interlock to prevent access unless the respective load break switch in the high voltage switchgear is in the open position. Co-ordinate keying with the switchgear manufacturer.

.21 The transformer enclosure shall be factory finished ANSI 61 grey.

.22 Certified test report on the transformer, including temperature, sound level, impulse, impedance regulation, winding loss, core loss, excitation, turns-ratio and polarity, shall be provided.

.23 Prior to energizing or commissioning the transformer, it shall be fully inspected, tested, checked and adjusted and the following verified:
   – Grounding;
   – Ratio;
   – Polarity;
   – Insulation Resistance.

.24 Transformer name plates shall be installed in accessible locations.

**16461.2 Dry Type Transformers – Low Voltage**

.1 Transformers shall comply with the latest requirements of ANSI-C57.12.01 and CSA C9.

.2 Transformers shall be of the indoor, air cooled, dry type of the size, rating and capacities to suit.

.3 Transformers shall have sprinkler proof enclosures.

.4 All windings and terminations shall be copper.

.5 Transformers shall be of the 1.2 kV Class, standard B.I.L. Insulation shall be Class H, 220°C, with maximum temperature
rise 150°C over 40°C ambient.

.6 Transformers shall have 4 primary 2.5% full capacity taps, 2 above and 2 below normal, with wires brought out to tap board. Provide tap changing board with links.

.7 Ample ventilation openings at top, bottom, front and sides shall be provided, but these shall be shielded to prevent access to the live parts.

.8 Transformers shall be equipped as required with eye bolts, braces, etc. to enable them to be wall mounted, floor mounted or suspended. Transformers rated larger than 75 kVA shall be floor mounted.

.9 External, anti-vibration isolation mountings shall be supplied and installed for all transformers, on minimum 4" high housekeeping pads.

.10 Transformers shall be factory finished ANSI 61 grey.

.11 Transformers shall be Harmonic Cancellation type.

.12 Transformer losses and high efficiency shall comply with ASHRAE/IES 90.1-1989.

.13 All K13 transformers should be replaced with the harmonic cancellation transformers as follows:
   - Harmonic cancellation transformers (kVA as indicated, Phase shift to be determined with the manufacturer, Voltage as indicated, 60Hz, 45dB, 200% rated neutral);
   - Performance Validation – Independent performance validation by US Department of Energy Test Lab for harmonic performance and energy efficiency is mandatory;
   - Energy Savings – Transformer must bear the Energy Star and Environmental Choice logos. Minimum efficiency shall be 98%;
   - Load Compatibility- K-20 load profile, crest factor of 5, without derating;
   - Insulation Class – Class ‘R’ (Class ‘H’ is not acceptable);
   - Operation Temperature Rise: 130°C;
   - Electrostatic Shield – Each winding is independently single shielded with full-width copper electrostatic shield;
   - Construction Standards – NEMA St-20 and TP-1, appropriate UL, CSA, and ANSI/IEEE standards;
   - Windings and Terminals – Copper;
   - Taps – four 2.5% taps, 2 above and 2 below nominal;
   - Zero sequence data – 95% ZS impedance, 0.3% ZS
reactance;
- Secondary Windings – Wound to cancel zero sequence current flux. These currents shall not be coupled into the primary windings of the transformer;
- Enclosure – E3R (Sprinkler proof enclosure) complete with anti-vibration pads. Floor mounted enclosure to be completed with 4” high housekeeping pads.

.14 Transformer name plates shall be installed in accessible locations.

16470 **Panelboards**

16470.1 **Lighting and Receptacle Panelboards**

.1 Panelboards shall conform to CSA requirements.

.2 Panelboards shall be factory assembled sprinkler proof type if in sprinkler area, dead front type, enclosed in Code gauge steel equipped with door having concealed hinges, lock and panelboard directory, and shall be suitable for surface or flush mounting as required. Panelboards shall be keyed alike and each panelboard shall be provided with two keys.

.3 Panelboard bus shall be copper and shall extend the full length of the panel. Neutral bus shall be rated 200% of main bus rating.

.4 Circuit breakers shall be ambient compensated type, calibrated at 40°C and be of the bolt-on type, without any plug-in connections. Multi-pole breakers shall have common trip. Circuit breakers for 120/208 Volt application shall have a minimum symmetrical interrupting rating of 10,000 Amps. For 600 Volt applications, the rating shall be minimum 35,000 Amps. All interrupting ratings shall exceed available fault level as determined by coordination studies.

.5 Tandem double density circuit breakers are not acceptable.

.6 Panelboards, including tubs, shall be factory finished ANSI 61 grey. Emergency power panelboards shall be green.

.7 Panelboards shall be of the same manufacturer as the switchboard.

.8 Panelboards are to be mounted so that the top of the panels are 6'-6" (2m) above finished floor.
.9 Panelboards shall be identified as LP (lighting) or RP (receptacle) or E (emergency) followed by the designation letter, voltage and current rating, and the designation of the source of power supplying the panelboard. Example: “LP3A1 120/208V 225A 3PH 4W Fed from Main Switchboard”. Panelboard identification shall be on engraved lamacoid plate, white letters \( \frac{1}{2} \)" high on black background for normal power panels, white letters on green background for emergency supply panelboards. Lamacoid plates shall be fastened to the outside of the panelboard with stainless steel screws. Pen size for lettering shall be 1 mm minimum.

.10 Panelboard directories shall be typewritten. Directories shall indicate the final room numbers as designated by Office of Space Management (OSM).

.11 Provide two 1" empty conduits from each flush mounted panelboard to the ceiling spaces above and below for future installation of wiring. The conduits shall terminate in junction boxes with fish wires.

.12 Provide filler plates on all blank breaker space.

16470.2 **Power Panelboards**

.1 Panel boards shall conform to CSA requirements.

.2 Panel boards shall be factory assembled sprinkler proof type if in sprinkler area, dead front type, enclosed in Code gauge steel equipped with door having concealed hinges, lock and panel board directory, and shall be suitable for surface or flush mounting as required. Panel boards shall be keyed alike and each panel board shall be provided with two keys.

.3 Panel boards shall be of the "CDP" type with the sizes and type of breakers as specified.

.4 Circuit breakers shall be ambient compensated type, calibrated at 40°C and be of the bolt-on type, without any plug-in connections. Multi-pole breakers shall have common trip. Circuit breakers for 120/208 Volt application shall have a minimum symmetrical interrupting rating of 10,000 Amps. For 600 Volt applications, the rating shall be minimum 35,000 Amps. All interrupting ratings shall exceed available fault level as determined by coordination studies.

.5 Splitter troughs incorporated in the panelboard shall be complete with copper bus bars the length of the trough.

.6 Panelboard bus shall be copper and shall extend the full length of the panelboard. Neutral bus shall be rated 200% of main bus rating.

.7 Panelboards shall be provided with non-ferrous plates for single conductor entry as required.
.8 Panelboards shall be of the same manufacturer as the main switchboard.

.9 No plug-in connections of any type are acceptable within a panelboard.

.10 Panelboards, including tubs, shall be factory finished ANSI 61 grey. Emergency power panelboards shall be green.

.11 Panelboard directories shall be typewritten. Directories shall indicate the final room numbers as designated by Office of Space Management (OSM).

16482 **Motor Starters and Motor Control Centres**
- Refer to Division 15 – Mechanical Services.

16510 **Lights**

16510.1 **Lighting Levels**

.1 Rooms where reading and writing is the major activity, such as tutorial rooms, offices, lecture halls, libraries and laboratories, the illumination level shall be 50 to 75 foot candles luminance at the performed task. Some rooms, such as laser rooms and computer terminal rooms, may require less illumination level than an office. The designer shall propose the illumination level to the U of T Project Manager for approval.

.2 Common areas, corridors, stairways, washrooms, elevators, lobbies, lecture rooms, the illumination level shall be 10 to 20 foot candles as a general lighting standard throughout the space.

.3 Bulletin boards mounted in corridors could be “spot lighted” for improved visibility.

.4 Sports facilities need to be specifically designed and provided for according to their use, and will not fall under this general lighting standard.

.5 Residences are a very subjective issue. They should also be specifically designed and provided for according to room function and tenant comfort. Their corridors, washrooms and stairways, though, should comply with the general lighting guidelines above.

16510.2 **Lighting Controls**

.1 All lighting systems, except those required for emergency or exit lighting, shall be provided with manual, automatic, and/or programmable controls. (E.g. motion sensors in large area).

.2 The washrooms shall not have switches at the door where people may switch the lights off and create an unsafe condition for others.
These areas must be controlled by keyed switches. Key switches shall be provided to control lighting fixtures in isolated exit door areas. The light shall be located both in the interior area and also on the exterior of the exit.

.3 Electronic classrooms shall be controlled by manual switches only, DO NOT USE touch screen switches.

.4 Programmable lighting control system may be used as part of a Building Automation System or an independent control system for the purpose of energy savings. The system shall be simple and user friendly, and have manual override or bypass feature. Submit proposal to the U of T Project Manager for approval. Provide all necessary equipment, accessories, manual, as-built documents, settings and passwords as required for the normal operation and adjustment of the system.

16510.3 Lighting Fixtures

.1 Lamps:
Fluorescent lamps: 4 ft., 32 watt, "T8" 3500 °K, or as otherwise specified. T5 lamps are acceptable.

H.I.D. lamps: Induction lamp or LED, 4100 °K.

.2 Ballasts:
Indoor installations:
Energy efficient electronic ballast for fluorescent lamp. Induction or LED lamps in high bay areas. Ballasts shall be instant start.

Outdoor installations:
Energy efficient lamps suitable for -30°C cold weather fluorescent lamp, induction lamps, or LED.

H.I.D. lamp’s ballast:
Energy efficient ballasts shall be located in accessible position.

.3 Exit Lights: LED type, long life, 120V, 4W HPF surge protected. Photoluminescent EXIT signs may be accepted in well illuminated areas. Submit proposal to U of T Project Manager for approval.

.4 Emergency Lighting = 12V; maintenance free, sealed lead battery; having a design life of 10 years and remote test feature. Emergency light fixtures that are fed from building emergency supply shall be identified with permanent markings with red dot or “E” on the end of the fixture.

.5 PL pot light fixtures shall be complete with vertical lamp.

.6 Light bulbs shall be specified to have a “natural” colour (metal halides, fluorescent etc).

.7 Pot lights with specular clear or gold reflectors shall not be used in
classrooms as they reflect the light and are very distracting especially in front of a classroom. Pot lights with black coilex baffles shall be used.

.8 Chalkboards lighting shall be provided in classrooms.

.9 A task light shall be provided at podiums. The type of task light used must be standardized so that it will be easier to stock and replace parts and bulbs.

.10 Lights along the stairs in lecture theatres shall be provided.

16510.4 Lamp Standards

.1 Lamp fixtures:

.1 Lamps shall be energy efficient induction or LED, 4100°K white suitable for -30°C cold weather outdoor installation.

.2 Ballasts shall be energy efficient and high power factor (0.9 or higher) electronic ballasts, located in accessible positions with easy disconnect plugs.

.3 Shape of light fixtures shall be such that no bird can stand on it nor build a nest around it.

.4 Globes shall be made of one-piece seamless injected-molded satin clear and UV resistant material.

.5 Provide easy access mechanism, such as hinges on hood with stoppers and captive screws, for access to the lamp, ballast and reflector. Provide good quality gasket to ensure weatherproofing.

.2 Poles:

.1 Height of lamp poles shall be 12 feet (3.658 metres) above ground level.

.2 Pole shafts shall be minimum 4 inches (100mm) in outside diameter.

.3 Pole shafts shall be made from round extruded aluminium tubing, welded to the pole base.

.4 Colour of poles shall be black mat.

.5 Pole finishes shall be highly durable UV and salt spray resistant, humidity proof and with anti-graffiti non-stick coating.

.6 Provide a minimum 2 inches X 4.5 inches (51mm X 114mm) maintenance opening centred 20 inches (508mm) from ground level, complete with weatherproof aluminium cover and a copper ground lug on each pole.
Provide identification tag with 2 inches high reflective white numbering on black background mounted on each pole at 10 feet (3 metres) above ground level.

Bases:
- Pole bases shall be hinged on one side.
- Provide 2-piece base cover made from cast aluminium, mechanically fastened with stainless steel screws.
- All exposed screws shall be stainless steel.

### Diesel Generator Set

#### General

1. Diesel generator set shall be rated as specified at 0.8 power factor for continuous prime power duty with 10% continuous overload capacity at 0.8 power factor.
2. New and retrofit installations of diesel generator set shall comply with Ministry of Environment requirements.
3. Diesel engine shall be full compression ignition type, four stroke single acting, for No. 2 diesel oil fuel injection with all accessories as required to comply with the specified functions and performances.
4. Engine speed at normal full load operation shall not exceed 1800 RPM.
5. Engine Governor capable of maintaining the engine speed within 3% of the rated frequency from no load to full load generator output. The frequency at any constant load, including no load, shall remain within a steady state band width of 0.25% of rated frequency.
6. Fusible fire shutoff valve to be installed in fuel supply line to the main tank and day tank.
7. Drip pan to be installed under the diesel engine.
8. Natural gas fired generators to be considered for non-life safety equipment.

#### Diesel Engine Starting System

1. The engine shall be provided with a 24 Volt electric starting system of sufficient capacity to crank the engine at a speed which will allow full diesel starting of the engine.
.2 Maintenance-free sealed type lead acid battery shall be furnished, having sufficient capacity for cranking the engine for at least 60 seconds at firing speed in the ambient temperature of 10°C, consisting of at least six 10 second cranking attempts, with battery and voltage not less than 80% rated voltage.

.3 Engine coolant heater: 120°F to 140°F (50° to 60°C), with auto cut-out on engine start.

16613.3 **Engine Instruments**

.1 An engine or generator-mounted instrument panel shall contain the following gauges for proper engine surveillance and maintenance:

- Engine water temperature;
- Engine lube oil pressure;
- Engine lube oil temperature;
- Engine running hour meter;
- Battery charging indicator;
- Engine fault indicators for oil pressure, water temperature, and engine speed.

16613.4 **Exhaust System**

.1 A suitable silencer, of the hospital grade, shall be furnished with the engine.

.2 A flexible, continuous, bellows type, stainless steel interlocking joints exhaust pipe, at least 24 inches long, shall be furnished for each engine exhaust outlet. The pipe outlet connections shall be compatible with standard ASA-125 lb. Pipe flange.

.3 The exhaust pipe shall be terminated at the highest point of and above and away from supply/exhaust systems. Provide rain guard on exhaust pipe. Muffler shall be insulated and shall have drain line extended to the floor drain of the diesel generator room.

16613.5 **Safety Controls**

.1 The engine shall be equipped with automatic safety controls which will shut down the engine in the event of low lubricating oil pressure, high jacket water temperature, engine over speed, engine over-crank, and electrical contacts for alarm lights on the alarm panel. In addition, pre-alarm signals for high water temperature, over speed and low oil pressure shall be provided.
16613.6 **Generator Set Performance**

.1 The voltage regulation from no load to rated load shall be within a band of 1% of rated voltage. The steady state voltage stability shall remain within a 0.5% band of rated voltage. Steady state voltage modulation shall not exceed one cycle per second.

.2 The voltage dip shall not exceed 20% of the rated voltage for any addition of load up to and including 90% of the rated load.

16613.7 **Engine Panel**

.1 Provide a wall-mounted or free standing panelboard having a hinged door and lockable door handle.

.2 The following equipment shall be mounted on the upper portion of door at eye level:
   - 3 thermal demand and indicating ammeters, flush mounted on door;
   - 1 voltmeter and voltmeter switch;
   - 1 frequency meter;
   - Engine alarms, including a common horn and indicating light for each of the following functions:
     - Engine water temperature;
     - Engine lube oil pressure;
     - Engine overspend;
     - Engine over crank;
     - Fuel supply;
     - Battery charger;
     - Alarm lamp test feature.
   - Synchronization to be discussed with U of T Project Manager and shall be provided or have provision for adding in the future.

.3 Provide all control logic, sequence of events, settings and passwords.

16613.8 **Testing of Diesel Generator(s) (Factory Testing)**

.1 Before shipment, the complete generating plant(s) shall be tested at the factory under actual load conditions for performance and proper functioning of component parts. The Owner's representative shall have the right to witness such tests. Provide 14 days notice of test date. The consultant will ensure that the contractor carries out the following:

.1 Provide an artificial load as required to test engine(s) at 100% and 110% of full kilowatt resistive load.
.2 Perform the following tests to include the diesel engine, generator and subsystems:

.1 Verification that all set components are correctly installed and interconnected.  C

.2 Verification that all subsystems are complete and operate according to design criteria.  NC

.3 Verification of voltage drop on assumption of load under the specified (simulated) conditions.  N/A

.4 Individual testing of each protective device and verification of the accuracy of control set points.  N/A

.5 Operate the diesel engine(s) from 0 to 100% simulated load, starting at no load and increasing in increments of 25%. Check at each load point stable operation, fuel consumption and engine performance.  N/A

.6 Operate diesel generating set(s) at 110% load for one hour or longer as required until engine temperature stabilizes.  N/A

.7 Provide a photograph of an oscilloscope trace of the generator output 60 cycle sine wave.  N/A

.8 Submit factory test results in writing for review by U of T prior to shipping of equipment.  N/A

.2 Before final acceptance of the installation, carry out testing at the site in the presence of the U of T representative.  N/A

.3 Provide an artificial load as required.  N/A

.4 Pay all costs for the services of a technician, provided by the supplier, to perform initial start up and testing for as long as necessary to verify the system performance and operation.  N/A

16613.9 Diesel fuel system – Refer to Division 15.

.1 Provide TSSA inspection and certification as required.  N/A

.2 Provide manual bypass valve on solenoid valve.  N/A

.3 Indicating lamps shall be LED.  N/A

.4 All vent pipes from the main diesel tank or day tank shall be directed to the outside of the building.  N/A
16613.10 **Automatic Transfer Switch**

.1 Automatic transfer switch shall be 4 pole, double throw, (complete with a manual transfer feature incorporating a spring handle), of current and voltage ratings as indicated, and all accessories as indicated.

.2 Automatic transfer switch shall be completed with the following features:

- Time delay normal to emergency (TDNE) adjustable from 1 to 60 seconds.
- Time delay emergency to normal (TDEN) adjustable from 1 to 60 seconds.
- Test selector switch (TSS).
- LED pilot lights: Normal supply (Green) and emergency supply (Red) in cover of enclosure.
- Normal source complete protection.
- Automatic operation.

.3 Provide all control logic, sequence of events, settings and passwords.

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**13860 Fire Alarm**

- Refer to separate Division.

**END OF SECTION**

**Recommended Manufacturers**

The list of recommended manufacturers of electrical equipment is updated frequently. Check with the U of T Project Manager for the most up-to-date list.
Electrical Design Standards – Bulletin #1

The following revisions are made to the Electrical Design Standards issued on July 12, 2010 and are effective immediately. They will be incorporated into the Standard at its next general re-issue.

The Project Manager must consult with the appropriate operating division of Facilities & Services Department before giving approval for any deviations from this Standard.

Replace Sections 16510, 16510.1, 16510.2, 16510.3, and 16510.4.1 to read:

16500 LIGHTING AND LIGHTING CONTROLS

PART 1: GENERAL

1.01 RELATED SECTIONS

1.02 (NB – These Sections to be announced. This 16500 can be read independently for lighting designs)

1.03 INTENT AND BACKGROUND

A. The University of Toronto (UofT) has committed to continuous and on-going energy use reductions and resource use efficiencies for all operations. These efficiencies are to be realized through standardized product specifications, integrated designs based on life cycle costing and best value for the U of T.

B. The intent of this section is to establish U of T’s guidelines for the design, specification, installation, and operation of interior/exterior lighting and lighting control systems.

C. This section will provide guidance to establish a degree of lighting solution consistency and standardization across campus. Fluorescent lights shall be T8-32W with instant or programmed start ballasts and suitable for the ambient temperatures and on/off cycles. For exterior lights, LED lamps and fixtures shall be preferred.

D. U of T requires systems that produce a comfortable, cost effective, efficient and safe illuminated environment. U of T also requires lighting control systems that are designed to be robust, reliable, maintainable, and easily operated. Finally, all life cycle cost assessments are to be considered for lighting systems, lamps, fixtures and lighting control systems.
E. Any proposed deviations from this standard must be submitted in writing to U of T project manager(s) for approvals.

1.04 DESIGN CONSIDERATIONS

A. ENERGY CODE

1. Designs shall meet lighting power densities requirements, levels and performance criteria established in the following reference standards:

   a. Ontario Building Code (OBC-2012)
   c. ANSI/ASHRAE/USGBC/IES 189.1 – 2009 Edition
   d. International Dark Sky Association – IDA/IES Model Lighting Ordinance
   e. Canadian Underwriters Laboratories
   g. Consortium for Energy Efficiency (www.cee1.org)
   h. Design Lights Consortium (www.designlights.org)
   i. Ontario Power Authority – saveONenergy Program Criteria (2012) (www.saveonenergy.ca)

2. Prepare a life cycle cost assessment for lighting solutions that presents the costs to operate and replace lamps over 10 year cycle min.

3. Certification: All lamps and fixtures shall be CSA, UL-Canada, or equivalent with recognized certificate marks in OESC; all fluorescent and compact lamps shall be Energy Star/Design Lighting Consortium listed, all ballasts shall be Energy Star/Consortium for Energy Efficiency listed.

4. LED technologies listed with Energy Star/DLC tested to IESNA LM-80-08.

5. All lamps shall be certified as required to meet applicable energy conservation Incentive program(s).

B. ILLUMINATION LEVELS

1. Unless otherwise indicated in this document, illumination levels shall conform to recommended minimum values identified by the current edition of the Illuminating Engineering Society of North America (IESNA) Lighting Handbook.

2. Lighting designer shall also refer to the guidelines of IESNA Recommended Practice RP-3, Lighting for Educational Facilities, 2010 Edition.

3. Exterior lighting levels will be based on IESNA/IDA lighting zone 2 (LZ2) hardscape criteria, refer to IESNA TM-15.

4. If task illumination levels as defined in the IESNA Lighting Handbook are not sufficient based on site specific application, ambient and task lighting...
levels may be adjusted to a higher level with concurrence of University of Toronto Facilities & Services. Ambient light level should not be less than one-third the task light level.

5. In small areas, such as restrooms or portions of egress areas, where a single luminaire is installed, specify a long life two-lamp fixture with instant start ballast so that the failure of one lamp will not leave the area in darkness.

6. Designer is to ensure that applications where dimming, daylight harvesting, high end trim, level scheduling or similar strategies are to be implemented can be achieved with selected lamps and ballasts.

C. LIGHTING EFFICIENCIES

1. Light loss factors
   a. Ballast factors should not be less than 0.88.
   b. The product of lamp lumen depreciation (LLD) and luminaire dirt depreciation (LDD) should not be greater than 0.65.
   c. Ballasts shall be parallel wired for multiple lamp fixtures to ensure at least one lamp stays on with single lamp failure.

2. Ensure operating temperatures for energy-saving lamps are suitable according to manufacturer’s guidelines and warranties.

3. All incandescent lighting is banned.

4. All fluorescent ballasts must be high power factor, energy-efficient, multiple-input types, CEE-Qualifying High Performance or Reduced-Wattage Ballasts, instant start or programmed start. Rapid start not accepted.

5. Where occupancy controls are used with fluorescent lamps, programmed start ballasts are to be used; where fluorescent lamps are on > 8 hrs/day, instant start ballasts are to be used.

6. Ballasts shall not interfere with infrared devices and be inaudible in a 27dBA ambient.

7. T8 long life Fluorescent lamps are base design and to meet the current CEE High Performance criteria and listed. Standard High-performance lamps shall be: 32W, T8, Med Bi-pin, ≥2,700 initial lumens, ≥60,000 hour life at 3 hours per start with programmed start ballasts, ≥90% lumen maintenance, CCT 3500-3700 K°, ≥80 CRI.

8. When T5 based solutions are pre-approved, ballasts will have end of life shut down circuitry, actively preventing overheating in linear fluorescent applications.

9. All non-LED fixtures will use initial luminaire lumens after efficiencies have been considered. If the fixture efficiency is not shown, 70% will be assumed.

10. All interior lighting solutions shall allow for strategies including high end
trim from 50% - 100%, occupancy/vacancy, daylight harvesting, personal dimming with compatible ballast/lamp combinations.

11. All switches shall be specification grade, rated, 20A, when used to control ballasted lamp fixtures.

12. See section 2.05 for Acceptable Manufacturers

D. LIGHT EMITTING DIODE (LED) LIGHTING SYSTEMS

1. Solid state lights (SSL) or LED, are the base lighting design solution for exterior applications. Follow IDA/IES darksky standards for LZ 2.

2. Fixtures such as pots, keyless lamp holders where lamps are on for >8hrs/day will compare LED with fluorescent using LCC analysis.

3. Equivalent LED lamp replacement for all applications, including CFL units, shall be based on initial luminaire lumens, assumes 70% fixture efficiency for non-LED fixtures.

4. All LED fixtures shall be cUL or CSA certified, be covered by a tier one factory supported min. 3 year parts warranty. Where applicable, wet location rated fixtures to be used.

5. Lamps will use chip on board (COB) version chip technology in lamps and/or/SMD for fixtures. Chip model and manufacturer to be submitted with every proposal/quote.

6. Colour temperatures to be 3700 – 4100 °K for interior applications and 5000 – 6000 °K for exterior applications.

7. For ceiling applications ≥2400 lumens; for flood wall, ≥2800 lumens; for entrance wall ≥700 lumens. Minimum luminous flux is 120 lm at 85°C.

8. Fixtures/lamps to be rated using LM-80-08 rating for > 35,000 hours on retrofit applications and > 50,000 hours for fixtures.

9. Exterior applications to have factory integrated photovoltaic light level sensor and control.

10. Flood light applications are to have >35° beam angle.

11. LED lamps will be base specified instead of halogen lamps. Retrofit pot fixtures to be Edison base LED preferred, > 50,000 hour life using LM-80-08 rating, CRI > 80, rated for wet and damp locations.

12. All LED lamps will include heat dissipation features to allow normal operation and design life in fixtures being specified.

13. See Section 2.05 for Acceptable Manufacturers.
E. LEED CERTIFICATION

1. Lighting and lighting control equipment shall be evaluated and suitable for contribution to LEED certification points.

2. Designer shall define and describe the applicable LEED point eligibility with the design.

F. INTERFACE

1. If used, Lighting Control System shall be capable of communicating to and have the ability to interface with and be controlled by the facility Building Automation Control System (BACS).

2. Lighting systems will communicate to the BACS using native BACnet IP protocol, and, therefore, not require a gateway or translator. It will communicate through the Facilities & Services Ethernet LAN to the enterprise management system.

3. Daylighting will be considered during fixture layout to ensure fixture dimming or shutting off within 5 m of perimeter outside windows when suitable light levels are present.

4. Office zoning shall allow for on/off/dimming and daylighting (where appropriate daylight levels available) controls individually.

1.05 TOTAL LIFE CYCLE COST OF OWNERSHIP

A. The lighting system design shall consider solutions that offer the lowest total life cycle cost of ownership.

B. The designer/engineer of record shall collaborate with all associated manufacturer’s to provide total cost of ownership information (life cycle cost analysis) for proposed lighting systems to U of T Facilities & Services. The designer shall prepare an energy density evaluation of the lighting systems.

C. Inductively coupled fluorescent systems may be considered for area where maintenance costs could be a factor.

D. Where possible, luminaire height should be kept to a minimum to allow lamp replacement from an 8 foot ladder.

E. All fixtures will be compared using initial luminaire lumens taking into consideration fixture efficiency. If luminaire efficiency is not shown, 70% will be assumed.

1.06 DOCUMENTATION
A. Designers shall submit the following information to U of T as required by contract documents. Coordinate the submission to allow for review and comment prior to the release of construction documents.

1. Luminaire, lamp, sensors and controls specification sheets.

2. Lighting calculations for all types of spaces, including foot-candle levels and watts per square foot (lighting power density) and energy density (kWh/gross floor area) based on a specified projected operation.

3. A point-to-point photometric layout shall be submitted for each typical space. Layout shall depict average, maximum and minimum illumination values in the horizontal work plane at 30 inches above finished floor level.

4. Additional information may be required to depict day lighting contribution and the impact to illumination values.

B. Reflected ceiling plans, specifications (lamp, ballast, & luminaire), calculations, renderings, and lighting control basis of design are to be provided for approval by Project Management.

C. A training plan including lighting design parameters, daylighting consideration, dark sky consideration, O&M criteria and controls operation is to be provided and its implementation is to be coordinated with U of T Project Management. Operation and Maintenance (O&M) manuals to be provided at the time training is conducted.

D. At the conclusion of the project, as-built documentation shall be submitted to reflect the final installed condition, including records of field settings.

E. The lighting controls manufacturer shall commission and certify in writing that the installed system meets all performance criteria.

F. Documentation required to complete any active incentive programs shall be provided with the design.

PART 2: PRODUCT REQUIREMENTS

2.01 SYSTEM DESCRIPTION/PERFORMANCE

A. Lamps and luminaires shall be selected for high efficiency, initial luminaire lumens including fixture efficiencies, application based illumination, low energy, and best value life cycle cost.

B. Lighting systems shall be designed to achieve the required levels of illumination while minimizing energy consumption. Illumination levels are measured in maintained horizontal foot-candles on a working surface located 0.75 m above floor level, within a tolerance of plus or minus 20 percent in non-work areas, in accordance with the current edition of the IESNA Lighting Handbook for average maintained lumens. Target levels to be < 1 W/sq.ft. for interior applications.
C. Fixture performance at design is to use initial luminaire lumens including efficiency. If efficiency is not specified, 70% will be used for non-LED luminaires.

D. Ballasts are to be remote-mounted only when considerations such as noise, temperature, radio-frequency interference, and electromagnetic fields are critical.

E. Fluorescent fixtures in areas where subjected to physical damage will use acrylic lenses or other approved protection.

F. High intensity discharge (HID) lamps are rarely appropriate for indoor use due to their low CRI, high energy usage and rated life expectancy. Efficient LED, high bay fluorescent (HBF) fixtures, induction lamps shall be base design consideration where HID would be considered.

G. Do not provide luminaires with fuses or receptacle outlets.
2.02 LIGHTING CONTROL REQUIREMENTS

The table below contains the control strategies that shall be considered for both retrofit and new construction work.

<table>
<thead>
<tr>
<th>Space</th>
<th>Occupancy/Vacancy</th>
<th>Daylight Harvesting</th>
<th>Scene Based Dimming</th>
<th>Personal Control</th>
<th>Central Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Residence Bedroom</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Classroom</td>
<td>A</td>
<td>B</td>
<td>A</td>
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<td>B</td>
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<tr>
<td>Conference Rooms</td>
<td>A</td>
<td>B</td>
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<td>B</td>
<td>B</td>
<td>B</td>
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<tr>
<td>Dining Halls</td>
<td>A</td>
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<td>B</td>
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<td>Kitchens</td>
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<td>Laboratories</td>
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<tr>
<td>Lecture Halls</td>
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<td>Lobbies</td>
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<td>Locker Rooms</td>
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<tr>
<td>Mechanical/Electrical Rooms</td>
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<td>Music Rooms</td>
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<tr>
<td>Open Office</td>
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<tr>
<td>Private Offices</td>
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<tr>
<td>Stairways*</td>
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<tr>
<td>Storage Areas</td>
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<tr>
<td>Toilets*/Common/General areas</td>
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<tr>
<td>Waiting Areas</td>
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<td>Workshops</td>
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<tr>
<td>Toilets-residence/private/handicap</td>
<td>A</td>
<td>B</td>
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</tbody>
</table>

**KEY:** *Where not in conflict with applicable codes. Consider partial shut-down strategies.
A - Required for this space     B – Optional for this space

2.03 LIGHTING CONTROL SYSTEM CONSIDERATIONS

A. OCCUPANCY/VACANCY SENSORS

1. Vacancy (manual on) sensors should be considered where nuisance activations could be an issue. All offices shall include occupancy controls.

2. Timeout options should have a range from 1 minute to 30 minutes.

3. Dual technology ultrasonic and passive infrared (PIR) devices are preferred.
4. If equipped with an integral photo sensor for daylight harvesting, this feature should have the capability to be disabled.

B. DAYLIGHT HARVESTING

1. Shall be considered for control of lighting in areas adjacent to exterior facades and in areas containing skylights. Shall be compatible with on/off and dimming strategies. Refer to ANSI/ASHRAE/IESNA 90.1/189.1 – 2009.

2. One exterior daylight sensor per facade is the required minimum. Designer to layout perimeter circuits to allow for daylighting control. Daylight control is to be capable of switching and continuous dimming of multiple zones.

3. All controls (daylight sensors, occupancy sensors, wall stations) shall be capable of connection directly to the ballast or LED driver for ease of installation. Upon loss of control signal, ballasts/drivers shall default to full on state.

4. Automated shading must be approved by the project manager before consideration.

C. PERSONAL CONTROL

1. Shall be provided to allow the user of the space to directly control the lighting in the space and include dimming. Where daylight harvesting is possible, personal control shall include daylight/dimming strategies.

2. Low voltage controls shall be compatible with 0 – 10 V program start ballasts.

D. SWITCHING SYSTEMS

1. Shall be utilized for areas where dimming is not appropriate. Centralized panels and distributed switching modules shall be rated for 1,000,000 electrical operations.

2. Switching Systems shall be capable of astronomic time clock and occupancy control.

3. Pin based Time clock systems are not allowed.

E. TOTAL BUILDING LIGHTING CONTROL

1. Digital lighting management (DLM) shall be considered in all new construction and renovation projects.

2. DLM shall be an intelligent, distributed control system that automatically maximizes lighting energy efficiency that includes room controllers,
3. DLM can be provided as a dedicated system, incorporated into the BAS or the design shall provide the specifications and sequences to use an existing or planned BAS technology.

4. DLM shall be capable of interfacing seamlessly with the F & S Ethernet LAN based enterprise management system for control, monitoring, and reporting using native BACnet IP protocol.

5. Shall continue to operate independently if communications with the BAS is lost. DLM shall be compatible with ballasts and lamps.

6. Shall provide the following capabilities to the BAS/BACnet IP system:
   a. Graphical display of energy consumption.
   b. Change sensor settings, set parameters for sensors, dimming, daylighting.
   c. Switch or dim individual loads.
   d. Activate scheduled pre-set scenes.
   e. Deliver occupancy status information directly to the BAS.
   f. Implement a dynamic load shed.
   g. Provide status of all components of the system.
   h. Implement after hours mode for set point change in occupied and unoccupied states.

2.04 MANUFACTURER SUPPORT AND COMMISSIONING

A. All lighting control equipment shall be integrated and commissioned to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer’s installation instructions.

B. When occupant sensors, time switches, programmable schedule controls, or photo sensors are installed, at a minimum, the following shall be confirmed:
   1. Placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.
   2. Time switches and programmable schedule controls are properly programmed.
   3. Photo sensor controls reduce electric light levels.
   4. Dimming levels are operating as programmed.

C. DLM control system supplier shall conduct, commission and certify the functional testing. Provide commissioning report, including all field settings.

D. DLM control system supplier shall provide technical support during normal business hours, maximum 24 hour turn around.
E. DLM control system supplier shall offer a commissioning service and service contract for the system being installed.

2.05 ACCEPTABLE MANUFACTURERS

Based on campus wide experience and in the interests of consistency for lamps and fixture types, the following technologies are pre-approved and must be used as base for any supplier designs, new and retrofit/renovation. Alternates must be approved by Facilities & Services before use.

A. Interior Spaces Fluorescent Lamps: OsramSylvania Octron series XB 800 (Base spec), GE Ecolux, Philips Advantage, Lutron; warrantied for three (3) years min.

B. Exterior and Interior LED lamps: Chip on board: CREE (Base spec), Sharp, Citizen or Bridgelux; warrantied for 5 years or longer

C. Fluorescent: OsramSylvania (Base spec), GE, Philips, Cooper, Core Products, Standard Products

D. Ballasts: OSRAM/Sylvania Quicktronic (Base spec), GE Ultrastart, Philips Optanium; Lutron; warrantied for 5 years

E. Control systems: Lutron Electronics, WattStopper, Encellium, GE, Douglas.

2.06 QUALITY CONTROL

A. After the lamps have been in service for approximately 100 hours, obtain foot-candle measurements during periods of darkness at a sufficient number of locations to demonstrate that the design criteria has been met. Submit the results to the University of Toronto Project Manager.

B. For noise, electrical or wireless sensitive applications, verify that ballasts noise/electrical/wireless specifications meet F & S specifications.

C. Acceptable suppliers are to be used as base design and signed off by authorized project managers. Alternates will be screened by the U of T project management before being allowed to supply.

D. Lamp, ballast and fixture manufacturers/suppliers will be dedicated and experienced lighting solution providers. Preference will be given to Tier One companies with local lighting solutions market presence > 5 years.

E. Must meet or cUL. CSA certifications, suitable and rated for the application, meet or exceed the University of Toronto Design Standards and be approved by the Project Manager.

--- END ---
January 14, 2014

**Electrical Design Standards – Bulletin #2**

The following revisions are made to the Electrical Design Standards issued on July 12, 2010 and are effective immediately. They will be incorporated into the Standard at its next general re-issue.

The U of T Project Manager must consult with the appropriate operating Division of Facilities & Services Department before giving approval for any deviations from this Standard.

**Replace Section 16123.2 (Page 9 of 56) to read:**

Use of AC90 (BX) cables:

For classrooms, laboratories and closed office areas with drywall partitions, type AC90 (BX) armoured cable shall only be used for fixture down drops above accessible drop ceilings with a maximum down drop not to exceed 6 metres (20 feet) from ceiling junction box to fixture. Armoured cables may be used for single drops from the ceiling junction box to supply wiring devices in drywall partitions.

For open office areas using system furniture and partitions where under floor wiring is undesirable, using BX cables to wire partitions from adjoining walls is acceptable.

BX cables must be neatly installed, coordinated and aligned with adjacent surfaces. BX cables must be independently and appropriately supported and must not rest on ceiling tiles.

In any case, confirm with the U of T Project Manager the extent to which BX cables can be used in the particular project being designed.

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Security and Access Control System Mandatory Requirements

The U of T security and Access Control System must be installed on all entrance and exit doors for all buildings that are being newly constructed or are undergoing significant reconstruction or repurposing.

The following information is provided for the use of the University of Toronto’s Facilities and Services Property Managers, Campus Police Services and the Project Management Office and the Consultant Teams working on new security and access control systems or additions to existing systems on the St. George Campus of the University of Toronto.

This Standard is also being used by the University of Toronto at Mississauga and the University of Toronto at Scarborough. Local variations may occur and it is expected that the Project Manager and Consultant will confirm their recommendations with the Managers of the security and access control systems at each campus before issuing the project specification.

Steps that MUST be taken once the project consulting team is formed on the St. George Campus:

At St. George Campus the consulting team is to contact Alan Truong, Manager, Security Systems and Services at 416 978-2905 (T) or Fax 416 946-8300 to identify the project and approximate timing.

The contact at the Mississauga Campus is Robert Messacar or his designate at (905) 828 5200.

The Contact at the Scarborough Campus is Carvill Lo at (416) 287-7599.

On the St. George Campus there are mandatory one time only and on-going fees that will be charged to the client. Clients must also agree to maintain the devices in good working order at all times and to repair or replace forthwith any device that is not functioning properly.

Centralized EBI and DVM servers are provided on the St. George Campus as are Code Blue DVM servers, making it unnecessary to purchase additional servers for any of the systems. Depending on the nature of the systems being installed, workstations and additional hardware may be necessary. The University of Toronto supplies and maintains all required servers, workstations and peripherals such as storage and printers for which the client is billed. Fees are subject to change and apply for the following:

- Shared servers, storage memory, workstations, printers and other required hardware;
- Licenses to operate on the Code Blue ToolVox system, Honeywell EBI system and DVM system;
- Credentials, scheduling and programming changes;
- Annual monitoring fee to Campus Police;
- Attendance at false alarm calls;
- Attendance at requests to provide access when the system is operating but the credential is not available;
All maintenance, upgrading and repairs to any device

Features

Unless otherwise specified:

The University has standardized on the Honeywell Enterprise Buildings Integrator software for security and access control and the Honeywell DVM system to manage video and surveillance systems. All products specified for the system must be recognized by and work in the software environment. Other products can work in the EBI software if a driver or other software is supplied. The product must be tested and accepted by the security system manager and only after it is proven to work as required in the EBI system. All of the hardware noted in this document has been proven to work as required. New hardware is being added to the list regularly and it is good practice to check with the respective managers to learn what is available for use with the EBI system.

All hardware must have a University supplied key override for any security door electrically locked. Such locks will accommodate Sargent standard mechanical or iLogic cylinders, in Large Format on the St. George Campus. All locks and keys are charged to the Client by the Lock Shop and should be carried as a project cost.

Acceptable locking devices include Sargent Wi-Fi/POE, and Harmony 2, 8000 series Rim Exit Devices that are connected to the Campus Honeywell EBI Security System. New locks are approved from time to time and project managers and designers should check with the Manager, Security Systems and Services at St. George Campus.

As of 2015 07 28, the Salto locking system has been added to EBI as a new install but a process and pricing has not been developed. Salto locking systems are installed in many areas of the St. George Campus. Salto systems are locally managed by the Client but are not part of the St. George Campus Security and Access Control system and are not managed, monitored or serviced by Campus Police Services. This is expected to change during the next year.

For new builds and installations, the Access Control System currently specified on campus is the PCSC Fault Tolerant System managed by Honeywell Enterprise Building Integrator (EBI) software. For expansions of existing systems, the PCSC iQ series may be used. All parts must be programmed to work with the PCSC controllers and FT devices.

When parts are being replaced or added to the system, there is a recognition process that is required in the EBI and DVM software. Prior to installation, the Manager, Security Systems and Services must be consulted and if required, the device will be configured, at the cost of the project, to work on the system prior to installation. This includes controllers and FT modules, card readers, cameras, door locks (wired, PoE and Wi-Fi) and peripheral devices.

All doors with the exception of overhead doors, shall report both forced open and door held unless otherwise requested by the University. The Manager, Security Systems and Services will identify those doors on which it may be disabled.
• Overhead doors shall be equipped with a door contact and key switch bypass.
• All elevators shall be equipped with a card reader to allow/restrict access to all floors so that they can be remotely locked down. Floor access will only be granted to a valid card holder. Floor tracking is not required.
• All decisions shall be controller based.
• Doors with automatic openers shall be interfaced so that the locking device is disengaged (unlocked) prior to the auto door operator attempting to open the door. (Avoid motor burnout and false alarms).

It is recommended that glass break detector be provided where there is a glass window integral in the door or surrounding glazing at Ground level. This may be removed by the client but the client must be advised in writing that failure to provide glass break protection may provide an undetected point of unlawful entry. The use of multiple motion detection devices may be a suitable alternative.

CCTV will be integrated into the EBI system (DVM) and 30 days of storage provided per camera. Costs for all licenses and server usage and memory will be made to the Client by F&S IT at St. George Campus.

All servers and computers will be provided by the University of Toronto. The University provides a virtual EBI server to which all new and added points are attached. Each project will be assessed a fee that covers the added capacity required by the project. The project pays for all licensing, network, storage and other fees required to be part of the system.

Network specifications will be provided by F&S IT on the St. George Campus; UTM IT at Mississauga and UTSC IT at Scarborough.

On the St. George Campus Code Blue ToolVox servers have been selected to manage the Campus Assist phone system. As the campus transitions to the VoIP telephony system, analog Code Blue devices will be installed to ensure that there is a means to call for assistance in emergent and urgent situations. Sufficient server capacity has been provided by the University. It is anticipated that Scarborough and Mississauga Campuses will follow the same protocols.
16701 Security Systems General Requirements

GENERAL

Reference
This Section supplements “The General Conditions” and forms part of every Section of the Security System Specification.

Related Work
Comply with relevant Sections of this and other Divisions as required.

Codes and Standards
Design and Installation work shall be provided in accordance with the applicable international, federal, provincial, and local codes or standards current at the commencement of installation, including, but not limited to:

- Canadian and Ontario Electrical Code
- Ontario Building Code
- National Fire Code of Canada
- CSA Standards
- IEEE Standards
- ULC Standards
- FCC Standards
- AODA (Accessibility for Ontarians with Disabilities Act)
- ADA (Americans with Disabilities Act)
- All University of Toronto Standards
- University of Toronto Asbestos Training Certification.
- And any other governing authority having jurisdiction.

Where more than one code or regulation is applicable, the more stringent shall apply.

Cable sizing, installation, identification and termination shall be provided in accordance with the manufacturer's technical installation guidance, in addition to the applicable codes above. In the absence of the manufacturer's recommendations on conductor application, the Contractor shall ensure that the cable selected meets all technical requirements of the equipment to be installed.

Comply with O.E.S.C. Electrical Bulletins in force at time of Bid submission. While not identified and specified by number in this Division, they are to be considered as forming part of related...
Standards.
Abbreviations for electrical terms are as per C.S.A. Z85.

This Section supplements "The General Conditions" and Division 1, and forms part of every Section of Division 16.

Definitions
Wherever the words "equal", "approved", or "approved equal" are used, it shall be understood to mean, "equal", "approved", or "approved equal" in the opinion of the Consultant only. Unless otherwise noted, provide the model and manufacturer specified with no substitutions unless approved by the consultant.

Wherever the words "install", "provide", or "supply and install", are used, it shall be understood to mean "provide and install, inclusive of all labour, materials, installation, testing, and connections" for the item to which referred.

"Concealed" is defined as "out of sight" in "normal" viewing conditions, and
Includes buried in concrete, above acoustic tile or gypsum board ceilings, within masonry or gypsum board constructed walls, within cable trays or below raised access floors.

Intent
It is the intent of these drawings and specifications that the Trade Contractor provides complete and operational systems as required.
Where differences occur, the maximum condition shall govern.
Any miscellaneous items, hardware, devices, wiring, etc., not specifically described, but required for the operation of the system, shall be provided.

Contractor
The contractor shall only submit products for which they are factory authorized to sell, install and service. The contractor shall furnish all equipment, accessories and material. This shall be done in strict accordance with specifications and applicable drawings as required for a complete and working system. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of the specifications.

University Provided Equipment
The University will provide the computers to be used for workstations, video servers and the EBI server. All computer systems are Dell based.
The University will supply the Security Management and Video Management software and licenses.
The University will provide all access control credentials (cards and fobs).
The University will provide all signage for use with video surveillance that is installed as part of
this system and managed by Campus Police. The signage is not suitable for video cameras
installed by others.
The University will provide all LAN/WAN connections and network equipment with the
exception of terminal servers and video streamers. The contractor will provide the cabling
to the point of connection to the University network and the University will make the final
connection.

**EBI Server Programming, Graphics and Final connection to the Front End**
The contractor (usually using Honeywell as the sub-contractor) will provide all EBI
programming, graphics, testing and final commissioning of the Access Control,
Burglar, Intercom and CCTV Systems.
It is the contractor’s responsibility to provide all programming of the Access Control, Burglar,
Intercom and CCTV Systems so that the systems can be tested prior to connection to the
Private Security Network.
It is the contractor’s responsibility to co-ordinate with the client and Honeywell to complete
final commissioning of all systems after final connection to the Private Security Network.

**Existing Conditions**
Visit the site and examine the existing conditions affecting the work of this
Division.
No claim for extra payment shall be made for extra work made necessary by circumstances
encountered due to conditions that were visible upon, or reasonably inferable from an
examination of the site prior to submission of the Bid.

**Shop Drawings**
Submitted Shop Drawings must indicate details of construction, dimensions, scale, capacities,
weights and electrical performance characteristics of equipment or materials, as well as
specification reference Section number, and project name.
Submitted shop drawings must indicate equipment and cable identification tag as described in
Item 1.25 “Identification”.
Shop drawings shall be drafted in electronic format AutoCAD format) and submitted for review
in the form of 1 (one) reproducible and 6 (six) prints, with sufficient space on the front for all
Consultant's and Contractor's "review" stamps. Prior to substantial performance, an electronic
as-built copy is to be given to the Owner.
Manufacturer’s literature and similar published information will be submitted for review in the
form of 6 (six) originals or photocopies, with sufficient space or a cover sheet on the front for all Consultant's and Contractor's "review" stamps. Prior to substantial performance, all drawings and literature is to be scanned into a PDF format by the contractor and given to the Owner on a CD or DVD.

Shop Drawings shall include wiring details and mounted details of all devices, single line and schematic design drawings, riser diagrams, Data Gathering Panel (DGP's) details and terminations, power supply details and load summaries, all raceways and conduits and diagrams showing interconnections with the work of other Trade Contractors.

Work affected by submittal shall not proceed until review is complete.

Changes made to the Shop Drawings by the Consultant will not affect the Contract Price.

Submit Shop Drawings for all material and equipment referred to in the contract documents including, but not limited to, the following equipment:

- Door Contacts.
- All perimeter and space protection devices.
- Card Readers, Cards and/fobs provided by U of T.
- Exit Buttons.
- Any other optional packages and components (as required for elevator control).
- Wire ways.
- Wiring Devices.
- Wiring diagrams of each distinctive door types, each system and devices.
- Equipment layout and wiring diagrams for all systems and enclosures.
- Interconnection diagrams to all existing equipment such as handicap door operators.
- Locations of all new access doors and/or hatches.

**Contract Drawings**

The Drawings for the Security work are diagrammatic performance Drawings only, intended to convey the scope of work and indicate the general arrangement and approximate location of devices, and the approximate sizes and locations of equipment and outlets. The Drawings do not intend to show Architectural, Mechanical or Structural details.

Do not scale or measure Drawings, but obtain information regarding accurate dimensions, from the dimensions shown on the Architectural Drawings, or by site measurements. Follow the Security Drawings for laying out the work.

Refer to the other Division's Coordination Drawings or visit the site, to become familiar with all conditions affecting the work, and verify suitable spaces exist, in which the equipment will be installed.

Make, at no additional cost, any changes or additions to materials and equipment necessary to accommodate Structural conditions (offsets around beams, columns, etc.).
Alter at no additional cost, the location of materials and/or equipment as directed, provided that the changes are made before installation, and do not necessitate additional materials.

Exact locations of all boxes, conduit, wire runs and devices shall be presented to the University of Toronto for approval in advance of any installation.

Install ceiling mounted components (such as cameras etc.) in accordance with dimensioned reflected ceiling drawings, prepared by the (Architectural) Consultant. In the absence of such drawings, refer to the security consultant.

Leave space clear, and install equipment to accommodate future materials and/or equipment as indicated or specified, or to accommodate equipment and/or materials supplied by other Trade Contractors.

Verify that the spaces in which the equipment is to be installed is sufficient and install all equipment to maintain headroom and clearances, to conserve space, comply with codes, and to ensure adequate space and access for future servicing. Confirm at the site, the exact location of equipment, outlets and fixtures, and the location of outlets for equipment supplied by other Trade Contractors, before installation.

**Coordination Drawings**

Prepare Drawings in conjunction with all Trade Contractors concerned, showing new and existing sleeves and openings for passages through structure, and any sleeves, conduit sizes, buried conduit and locations for inserts in cast-in-place or pre-cast concrete, required for this work.

Prepare the Drawings and show cable and conduit runs, security, equipment rooms, ceiling spaces and all other critical locations to avoid conflict. Base the Drawings on Shop Drawings and include all details pertaining to clearances, access, sleeves, electrical connections, location and elevation of pipes, ducts, conduits, etc., obtained from consultation with and agreement of all other Trade Contractors involved, or site conditions.

Forward all the Drawings, reviewed by all Trade Sub-Contractors, to all Consultants for their review. Provide print copies as required.

All Drawings shall be prepared in ample time for review and implementation. Failure to do so, and any problems that arise, will be the responsibility of the Trade Contractor. Should the Trade Contractor neglect or otherwise fail to provide co-ordination drawings, it shall assume the cost of any and all relocation work that could have been avoided through the submission of co-ordination drawings.

**Record Drawings**

Prepare a complete and separate set of white prints to keep on the site at all times. These prints shall be marked up to record clearly, neatly, accurately and promptly:
All locations of security work, deviations from and changes to the "Issued for Construction" Documents.
The accurate locations, depth, size and type of each underground security run will be recorded before concealment, to ensure accurate and future direct access to these buried services.
Routing of signal wire and cables, including the designations assigned to each wire/cable and antenna placements.
Accurate location of all equipment installed under the specifications.

The Record Drawings will be reviewed at regular intervals by the Consultant, and will be taken into consideration when reviewing the monthly applications for progress payment.
Project Record Drawings include all bid drawings and all submittals.
The Security System Contractor shall obtain, pay for, and keep up-to-date and available to the University of Toronto or its representative, complete blue line prints the project clearly annotated with "as-built" data as the work is provided.
Any University of Toronto backgrounds required shall be obtained at Security System Contractors sole expense.

**As-built Drawings**
As-built drawings, in AutoCAD format, must indicate all cable and equipment identification tags.
The Security System Contractor shall provide all security as-built information for incorporation into the As-Built Drawings including, but not limited to, the panel and circuit numbers of all power feeds.
As-built drawings shall contain all required information provided in the shop drawings and the up to date record drawings to reflect the installation when complete.
Provide one (1) paper copy of all as-built documents and provide electronic copies of all documents for the University and provide one (1) paper copy for consultant’s approval.
As-built documentation shall be provided prior to substantial completion can be awarded.

**Operation and Maintenance Manuals**
Provide complete and accurate information in a uniform intelligible manner consistent with UofT requirements.
Provide three (3) hard copy sets of operation and maintenance manuals and one (1) set in electronic format on CD including all scanned and AutoCAD shop drawings and product literature as described in ‘Shop Drawings’ in this specification section.
The Operation and Maintenance manuals shall include, but not limited to, the following information:
Details of design elements, construction features, component function and maintenance
requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation. Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature is not acceptable.

The Consultants reviewed as-built shop drawings.
After completion of all systems, complete equipment, panel and cable schedules. Review information provided in the maintenance instructions and manuals with the Owners operating personnel to ensure a complete understanding of the electrical equipment and systems and their operation.

Access Doors
Wherever any item of security equipment requiring accessibility, maintenance or adjustment is concealed, ensure adequate access, or provide an Access Door and carry all cost for material and labour.

Doors shall be sized for proper and easy access, and located to suit the concealed device. In removable acoustic panel ceilings, no Access Doors are required. Use ULC labeled rated Access Doors in all fire rated walls and ceilings, which act as fire barriers and match the Door type with the ceiling or wall type and applied finish.

Submit for the Consultant's review, floor plans and shop drawings showing the size, type and exact location of all Access Doors.

All Access Doors and tiles requiring removal shall be shown on the Record Drawings.

Drilling
All required drilling shall take place during off-hours. Drilling schedule is to be approved by the University of Toronto Facilities and Services Department prior to any drilling taking place.

Cutting and Patching
All cutting and patching required for the installation of new equipment after Consultant's approval will be carried out by the appropriate trades at the Security Contractors expense. Prepare drawings showing the extent of the work and submit for the Consultant's approval.

Inform other Division Trade Contractors in sufficient time with regard to required openings. Where this requirement is not met, bear the cost of all cutting and patching.

In existing work, and work already finished, cutting and patching will be carried out by the appropriate trades at the Security Contractors expense. Be aware of fire rated partitions, minimize the area affected by the work. Acceptance of the finished work is at the sole discretion of the Consultant.
Painting of finished surfaces damaged by the Security Contractor or required by Security Contractor will be by an appropriate contractor at the Security Contractor’s expense.

Sealing
Where cables, cable tray, or conduits pass through non fire-rated floors, walls or roof, provide internal and external sealing thereto.
Comply with manufacturer's installation instructions for all sealant applications.
Refer to architectural drawings for location of fire ratings.

Fire Stopping
Fire-stopping and smoke seal materials and/or systems to provide closures to fire and smoke at opening around penetrations, at un-penetrated openings, at projecting or recessed items, and at openings and joints within fire separations and assemblies having a fire-resistance rating, including openings and spaces at perimeter edge conditions shall be supplied and installed to meet the requirements of the fire and/or smoke ratings required.

Sprinkler proofing
For all areas of this building that are protected by a wet sprinkler system, security equipment shall be provided for installation in such an environment.
Provide couplings with waterproof bushings when entering or exiting from top of equipment.
Provide drip shields on all DGPs.

Cleaning
Clean all tubs and other surfaces that have been exposed to construction dust and dirt. Clean the insides and outsides of panel boards, splitters and other security equipment, and completely remove all debris and tools from the project.
At the end of each workday, all areas shall be cleaned and left in a tidy manner with all tools and materials stored in a provided secure area.

Completion of Contract
All the equipment must be cleaned and tested, before certification of Substantial Completion by the Consultant.
From the date of issuance of final system acceptance by the Owner, all Equipment, materials and workmanship, must be unconditionally warranted for not less than 1 (one) year, complete with 24hr/7 days a week 4 hour response time.
Defects and deficiencies that originate or become evident during the warranty period shall be
repaired or replaced, at no cost.
All work relating to the replacement of defective items shall be carried out at a time that is acceptable to the Owner.
The Contractor will assume liability for costs incurred due to these defects affecting the University operations.

**Expediting**
Continuously check and expedite delivery of all materials and equipment required for the successful execution of the work.
If requested by Consultant, inspect at the source of manufacture, to confirm status, and submit an itemized flow chart of equipment order and delivery dates.
Continuously check and ensure that the necessary information is communicated to all parties involved.
Immediately inform the Consultant in writing of any anticipated delays.

**Field Supervision and Workmanship**
Throughout the construction of the work, a properly qualified Superintendent must be available at all times. The Superintendent who starts the work must not be changed unless requested by the Consultant, or by the Trade Contractor with written permission from the Consultant.
Provide proper office supervision of the work. The person responsible for office supervision shall visit the site as often as necessary, to ensure work is properly performed, and attend meetings when so requested.
Submit resume of proposed supervisory staff when called upon to do so by Consultant.
Workmanship throughout shall conform to the highest standards applicable.

**Identification**
Identify all security equipment and wiring.
All cables, wires, wiring forms, antennas, terminal blocks and terminals shall be identified by labels.
All equipment nameplates and labels shall be consistent with University of Toronto standards.
Wording on nameplates and labels to be approved by the Consultant and shall be in English.
Use nameplates for:
- Data gathering panels, indicating designation, voltage, phase, number of wires and location of feed.
- Terminal cabinets, indicating system and voltage.
Nameplates shall be Lamicoid, 3mm (1/8") thick, with a face colour to match the colour of the
equipment on which it is mounted, and a contrasting (black or white) core. Nameplates shall be mechanically attached to equipment.

Labels shall be of the Mylar/cloth self-adhesive type, black typed, not hand written, lettering on white background, for all conduits and cables, and located at each end of the run and at junction and pull boxes.

Use coloured paint dabs on the inside of outlet box, pull box, and panel cover as it is installed. In ceiling spaces, provide colour to outside of boxes also. Paint colour to match system colours as defined in "Finishes". Paint colour code shall be as follows:

- Orange - Security System
- Green - 120-volt power

Use plastic self-adhesive tape to identify incoming utility source lines; feeders, sub-feeders and bus work in each switchboard and unit sub-station.

Tape colour code shall be as follows:

- Red - Phase A
- Black - Phase B
- Blue - Phase C
- White - Neutral
- Green - Ground

Complete all DGP directories with neat, type written list of circuit numbers and item controlled. DGP directories shall be laminated and inserted into sleeves mounted to the back of the cover of the termination cabinets.

**Inserts, Hangers and Sleeves**

Provide hangers, inserts, sleeves and supports as required.

Refer to the applicable specification section for inserts. Hangers shall not be welded to structural steel members and burning of holes in structural steel is prohibited.

Sleeves in new construction are to be of a type suitable for the application, and be sealed and made watertight. Sleeves through concrete shall be schedule 40 steel pipe, sized for free passage of conduit, and installed flush with underside of concrete slab and extend 100mm (4") above finished floor.

Be responsible for the installation of sleeves in accordance with the Construction Schedule.

**Location of Devices**

Locate devices from dimensional Architectural elevation drawings or from site coordination documents prepared by the Construction Manager. Do not install devices back-to-back in walls,
but allow minimum 150mm (6") horizontal clearance between boxes. 
Change location of devices, at no extra cost or credit, providing distance does not exceed 3m 
(10 ft.) and information is given before installation. 
Where devices are shown adjacent to one another in plan but occur at different elevations, 
they shall be vertically aligned. 
Exact location of all boxes, conduit, wiring runs, panels and devices shall be presented to the 
University of Toronto for approval in advance of any installation.

Materials and Equipment
Materials and equipment shall be new, C.S.A. certified, and manufactured to the standards 
specified. 
Where there is no alternative to supplying equipment that is not C.S.A. certified, Obtain special 
approval from the local Inspection Department. 
Be aware that all equipment, whether "Base", "Approved equal" or "substitute" must fit into 
the space allocated. Be responsible for any increase in space requirements, due to non-
conformity to the above requirement. 
If a single item is specified, the specified item shall form the basis of the Bid, with no substitutes 
allowed.

Mounting of Equipment and Devices
Mounting height of equipment is from finished floor to centre line of equipment unless 
specified or indicated otherwise. 
Mounting heights shall conform to ODA/ADA requirements. 
If mounting height of equipment is not indicated, verify with Consultant before proceeding with 
installation. 
DGP’s - Top at 2400mm (8'-0")
All equipment shall be wall-mounted with sufficient clearance to meet all applicable codes and 
facilitate observation and testing. Units shall be installed parallel and square to building lines.

Noise, Heat and Vibration
If, during construction or the warranty period, power supplies or other material or equipment is 
producing excessive noise, heat or vibration, the equipment will be considered by the 
Consultant to not meet the specifications and these products shall be replaced without delay or 
additional cost to the Owner. 
Connections to noise-producing and vibrating equipment must be made with flexible conduit. 
This includes transformers (both power and distribution), dimming equipment racks, generator 
set and motors.
Owners Equipment
Where specified, install all equipment provided by the Owner.
Receive, store and install equipment, and accept full responsibility for it and its correct operation.

Panel Enclosures
It is the contractor’s responsibility to provide enclosures large enough to ensure that the wiring of the panels is done in a neat and professional manner. If the manufacturer’s provided enclosures are not of a sufficient size to wire the panel in a neat and professional manner, properly sized enclosures shall be provided.

Permits and Fees
Submit to the local Electrical Inspection Department, and Local Utility, the necessary number of Electrical Drawings and Specifications for examination, special inspection and/or approval, prior to the commencement of the work, and pay all costs, and associated fees. If required prepare any additional drawings/documents required by the Authority.
The Consultant will provide upon request, the required quantity of drawings and specifications. Provide Certificate(s) of Acceptance from the Authorities Inspection Department, upon completion of work.
If Maglock permits are required, include the cost of document preparation and building permit costs.

Plywood
Supply and install all plywood backboards as required for this Division, and in Tele/Data Rooms as shown. Plywood shall be highest quality fire retardant fir, 1200mm wide x 2400mm high (4'-0" wide x 8'-0" high), 19mm (3/4") thick. Prime and paint backboards on both sides with fire retardant paint, equal to CGSB Spec. #1-GP-151M, of a colour to match the equipment and services mounted thereon as defined in "Finishes" above.
Plywood backboards or Unistrut are to be used for mounting the following surface wall mounted equipment thereon:
- Cabinets
- GFI Equipment
- Pull Boxes
- Security equipment
Where practical, group devices on a common backboard.
Emergency Power and Battery Back-up

120VAC, 60Hz power shall be provided from the nearest emergency power electrical panel, through a junction box, to the system device, unless otherwise specified or by using a standalone APS UPS.

Breaker locking device shall be placed on all circuit breakers feeding any device, including but not limited to power supplies, connected to the security system.

Circuit Breakers to be installed and supplied by the University of Toronto.

All DGP’s and power supplies shall have battery backup to keep the systems fully functional for a minimum of 4 hours.

Progress Payments

Submit a complete breakdown of the Contract Price with each progress billing, indicating percentage of work complete, in a form acceptable to the Owner/Consultant.

Protection

Protect exposed live equipment during construction for personnel safety.

Install doors for temporary storage rooms containing the Trade Contractors non-installed security equipment. Keep these doors locked, except when under direct supervision of Electrician.

The Security Trade Contractor's qualified Superintendent shall be present for all concrete pours in order to witness and accept responsibility for protection of equipment.

Restrictions

Tele/data rooms and closets are designed for tele/data, Fire Alarm and Security Data Gathering Panels (DGP's) and equipment only. Do not locate any other electrical equipment therein, nor use these rooms for risers or feeders for services except for voice and data equipment, unless specifically shown on the drawings.

Temporary Service

If required, others shall provide a temporary electrical service.

Provide extension cords, extension lighting and equipment required for the work of this trade.

Valuation of Changes

The Consultant will scrutinize submissions and therefore require complete detailed itemization of all material, labour, unit prices and overhead and profit mark-ups.
Voltage Ratings
Operating voltages shall be as indicated in C.S.A. C235.

Warning Signs
Provide warning signs, as specified to meet requirements of Ministry of Labour Safety Inspection, Inspection Department, Authorities having jurisdiction and Consultant.
Use decal signs, in English minimum 750mm x 250mm (7" x 10") in size as required by Authorities.
On all system enclosures where potential over 70V is present.

Wire Pulling Lubricant
Lubricant shall be non-corrosive and CSA approved for the type of cable used.
Lubricants shall be soap or wax based, depending upon application. Use soap based for short runs and for semi-conducting insulated wires, and wax based for long runs.

Unit Prices
Unit pricing, when submitted, shall be used for the addition or deletion of the items as stated.
When changes are issued, the change will be priced in reference to the difference of the change not the unit price. (i.e. Door type on a door in the contract changes to another door type, devices that are similar between the door types are not deleted then added, only the sum difference between the door types will be priced.)

End of Section
16702 Conduits, Boxes, Fasteners and Fittings

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Related Work
Comply with relevant Sections of this and other Divisions as required.

PRODUCTS

Conduits
Rigid Metal and Epoxy Coated Conduit shall be threaded, galvanized steel and shall be manufactured to CSA C22.2 No. 45.
Electrical Metallic Tubing (EMT) and couplings shall be manufactured to CSA C22.2 No. 83. Couplings shall be steel setscrew type.
Rigid PVC Conduit shall be manufactured to CSA C22.2 No. 136.
Flexible Metal and Liquid-Tight Flexible Metal Conduit shall be manufactured to CSA C22.2 No. 56.
Rigid PVC Conduit shall be manufactured to CSA C22.2 No 211.2.
Conduit accessories, conduits and fittings shall conform to CSA C22.2 No. 18.
Explosion-proof flexible metal conduit shall be manufactured in compliance with the category (Class) of protection required.

Conduit Fastenings
For Rigid or EMT conduit, one-hole steel straps to secure surface conduits 50mm and smaller.
Two-hole steel straps shall be used for conduits larger than 50mm.
For PVC conduit two-hole heavy-duty straps shall be used.
Beam clamps to secure conduits to exposed steel work.
Channel type supports for two or more conduits.
Six mm diameter threaded rods to support suspended channels.

Conduit Fittings
Fittings shall be manufactured for use with conduit specified. Coating shall be same as conduit.
Bushing and connectors shall be with nylon-insulated throats.
Provide knockout fillers to prevent entry of foreign materials.
Use conduit outlet bodies for conduit up to and including 32 mm (1-1/4") and pull boxes for larger conduits.
Provide double locknuts and insulated bushings on sheet metal boxes.
Factory "ells" where 90° bends are required for 25 mm and larger conduits.
Steel set screw or rain tight insulated steel connectors and couplings for EMT.
Explosion-proof fittings shall be manufactured in compliance with the category (Class) of protection required.

**Expansion Fittings**
Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.
Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19mm deflection in all directions.
Weatherproof expansion fittings for linear expansion at entry to panel.

**Device and Conduit Boxes – General**
Boxes shall be suitable for the utilization voltage.
Combination boxes shall have barriers where outlets for more than one system are grouped.
Recessed 100 mm (4") square or larger outlet boxes shall be complete with single or ganged plaster rings to suit application.

**Sheet Steel Device Boxes**
Electro-galvanized steel single and multi-gang device boxes for flush installation, shall be minimum size 75 mm x 50 mm x 37 mm (3" x 2" x 1-1/2") unless otherwise specified or required. 100 mm (4") square outlet boxes shall be used when more than one conduit enters one side, with extension and plaster rings as required.
Boxes for door switches and push buttons shall be sized as required.
Utility boxes for connection to surface mounted EMT conduit, shall be minimum 100 x 54 x 48 mm (4" x 2-1/8" x 1-7/8") size.
Square or octagonal outlet boxes for lighting fixture outlets, shall be minimum 100 mm (4") size.
Square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls, shall be minimum 100 mm (4") size.

**Masonry Boxes**
Electro-galvanized steel masonry single and multi-gang MBD boxes shall be used for flush mounted devices in exposed block walls

**Concrete Boxes**
Electro-galvanized sheet steel concrete boxes shall be used for flush mounting in concrete, with matching extension and plaster rings as required.

**Conduit Boxes**
Cast FS or FD ferroalloy boxes with factory-threaded hubs and mounting feet shall be used for outlets connected to surface mounted rigid conduit.

**PVC Boxes**
F Series and octagon boxes shall be moulded type, with fastening ears and screw-secured covers as required.

**Fish Cord**
Pulling cables shall be Polypropylene and of a strength suitable for tension to be pulled.

**EXECUTION**

**Location of Conduit**
All conduit and wiring shall be concealed.
Asbestos may be present in any and all locations. Ensure proper installation methods are followed for work in areas that are deemed to have asbestos. If it is unclear whether asbestos is present, it is the contractor’s responsibility to test the area or conduct the work required as if asbestos is present.
The typical standard drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

**Installation**
The conduits for the following circuits and systems shall be run separately:
- CCTV
- Access control & Burglar
- Intercom
- Power

Install all wiring, including but not limited to branch circuit and signal wiring, in surface mounted EMT conduit in ceilings, furred spaces, and in hollow walls and partitions, unless otherwise specified. Install surface mounted wire mold in finished surfaces as specified.
Rigid PVC conduit shall be used throughout below grade areas and may be used under slab on grade areas. Do not use PVC conduits in slabs below or above grade. All conduits shall be surface mounted to minimize risks of future damage when core drilling during future renovations.
Use rigid galvanized steel conduit for wiring where conduits are exposed to possible mechanical damage.

Use PVC conduit for wiring in poured concrete.

Use epoxy coated rigid galvanized steel conduit for wiring in corrosive areas.

Flexible steel conduit is permitted for the final connection to devices mounted in suspended ceilings from the branch wiring junction box above, with flexible conduit length not to exceed 3 m (10’), and be neatly installed and attached to device support. Flexible conduit and armored cable will be accepted in parts of existing building, where furred spaces above ceilings are too congested to permit conduit to be installed, but only with Engineer's written permission. Terminate armored cable, where shown, in accordance with the manufacturer's recommendations.

Use liquid tight flexible metal conduit for connection to vibrating equipment.

Use explosion proof flexible connection for connection to explosion proof devices.

Use rigid galvanized steel conduit for wiring where conduits are exposed to possible mechanical damage.

Use rigid galvanized steel conduit for wiring where conduits are exposed to possible mechanical damage.

Aluminum conduits shall not be used.

Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass. They shall be installed as close to building structure as possible such that, where concealed, necessary furring can be kept to a minimum.

Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.

Conduit shall be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

Where existing locations of flush mounted electrical devices correspond to new devices shown, the existing down drop conduit and outlet box may be re-used. Provide new devices, new cover plates, new home-run conduit and complete new wire.

Vertical raceways to be provided with insulated cable support bushings or other approved method of supporting the weight of the cable, where vertical runs exceed those of Table 21 of the Electrical Code or where indicated.

Install conduit-sealing fittings in hazardous areas and fill conduit with compound.

Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

Mechanically bend steel conduit over 19mm (3/4”) dia.

Field threads on rigid conduit shall be of sufficient length to draw conduits up tight.

Run 2-25 mm (1”) spare conduits up to ceiling space and 2-25 mm (1”) spare conduits down to ceiling space from each flush panel. Terminate these conduits in 150 x 150 x 100 mm (6” x 6” x 4”) junction boxes in ceiling space or in case of an exposed concrete slab; terminate each conduit in flush concrete type box.
Where conduits become blocked, remove and replace blocked section. Where a block conduit is buried in concrete, abandon it and provide surface mounted conduit, to be located as determined by the Consultant. Do not use liquids to clean out conduits.

Conduit manufacturer’s touch up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

Install junction boxes or cable anchor boxes wherever necessary for proper pulling or anchoring of cables. Install so as to be accessible after building is completed and set to come within finished lines of building.

Where EMT, PVC or rigid PVC is used or where indicated, run green insulated ground wire in conduit, with minimum one ground conductor per three ungrounded conductors.

Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.

Install fish cord in empty conduits.

Dry conduits out before installing wire.

Conduit fills shall not exceed forty percent (40%).

**Surface Conduits**

Run parallel or perpendicular to building lines.

Locate conduits behind infrared or gas fired heaters with not less than 1.5m clearance.

Run conduits in flanged portion of structural steel.

Group conduits wherever possible on suspended or surface channels.

Do not pass conduits through structural members except as indicated.

Do not locate conduits less than 75 mm (3”) parallel to steam or hot water lines with minimum of 25 mm (1”) clearance at crossovers.

**Concealed Conduit**

Do not install horizontal runs in masonry walls.

Do not install conduits in terrazzo or concrete toppings.

**Conduits in Cast-in-place Concrete**

Conduits shall not be buried in slabs unless specifically noted otherwise.

Where permitted, locate to suit reinforcing steel. Install in centre one third of slab and ensure that conduits are completely encased in a minimum 50 mm (2”) of concrete. Organize conduits in slab to minimize crossovers.

Protect conduits from damage where they stub out of concrete by transitioning to manufactured rigid conduit elbows or by the use of junction boxes and extension rings.

Install sleeves where conduits pass through slab or wall.

Where conduits pass through waterproof membrane provide oversized sleeve before
membrane is installed. Use cold mastic between sleeve and conduit.
Do not place conduits is slabs in which slab thickness is less than 4 times conduit diameter.

Conduits in Cast-in-place Slabs on Grade
Run conduits 25 mm (1”) and larger below slab and encased in 75 mm (3”) concrete envelope. Provide 50 mm (2”) of sand over concrete envelope below floor slab.

Conduits Size
The minimum conduit size to be used is 19mm (3/4”).

Boxes
Support boxes independently of connecting conduits.
Fill boxes with paper, foam sponges or similar approved material to prevent entry of construction material.
Size box wiring chambers in accordance with Electrical Code.
Gang boxes together where wiring devices are grouped.
Provide matching blank cover plates for boxes without wiring devices.
Use combination boxes where outlets for more than one system or voltage are grouped.
For flush installations, mount outlets flush with finished wall using plaster rings to permit wall finish to come within 5 mm (1/4”) of opening.
Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
16703 Security System Wiring

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Related Work
Comply with relevant Sections of this and other Divisions as required.

General Requirements.
The purpose of this document is to specify installation standard of the wiring system for the Card Access, CCTV, Security and Intercom Systems for the University of Toronto security projects.
The contractor shall provide conduits, wire ways, back boxes for all components and interconnecting wiring.
The contractor shall provide coordination and interfacing with the supplier of the architectural hardware.

Summary of Work Included
Provide and test the installation of the cabling for the card access, CCTV, security and intercom systems to provide complete and functioning systems.
The system shall include connection to architectural hardware devices and field devices as shown on the Drawings.
All wiring and connection to interfacing systems, including but not limited to, fire alarm, closed circuit television, intercom, door hardware and door operators shall be provided and coordinated with the appropriate contractors.
The quantities of components shall be determined and installed based on the requirement to provide a complete and fully operational wiring infrastructure for Security System, as per the intent of the specification, and as shown on the drawings and recommended by the manufacturer.

PRODUCTS

Quality Assurance
Manufacturer Qualifications
Standard of Acceptance
EXECUTION

Installation

The security system wiring classification and installation for the trunk cabling between the central equipment, converter panels, card reader controllers and remote alarm terminals shall be Class "B".

All cables are to be FT4 in a conduit unless specifically identified otherwise. Where specifically called for, cables not installed in conduit shall be FT6 rated.

All cables to comply with the equipment manufacturer specifications. All signal cables for the security system shall be cables with individually shielded pairs of twisted and multi-strand wires unless otherwise specified by the manufacturer. All shield wires to be grounded at one end of the cable. All unused wires in a cable to be grounded at one end of the cable.

All cabling shall be continuous and free of splices. Cables may only terminate at point of final connection with the exception of approved patch panels.

Cables shall not enter any box or equipment enclosure, unless the cables are terminated in that enclosure. Designated pull boxes are exempt from this requirement and shall not have any terminations or splices made in the pull box.

Cables, cable bundles or wire bundles shall be clamped at least once between the point of cabinet entry and the connecting point.

Wires and cables, with the exemption of conduits and ducts, shall be combined into bundles wherever possible and shall be secured by means of flat lacing cord, nylon tie wrap, or other means acceptable to the Consultant. Self-adhesive cable clamps or cables anchors are not acceptable.

Cable ties shall prevent slippage and at the same time shall not deform the cable insulation or determine insulation cold flow.

Where nylon tie wraps are used, tails should be cut flush with no exposed sharp ends.

Bundled wires and cables shall be parallel to one another and shall not entwine other conductors or cables. This requirement should not be construed as prohibiting the use of twisted pairs, where required. Branched leads may cross other conductors if required.

All cabling shall be home run from the device to the termination panel. No field interconnection will be allowed. The only exception is multiple doors that share common mullions and are designated by a single door typical.

Cable size and length shall meet the manufacturer’s recommendations and all applicable codes and standards.

All termination points, including but not limited to screw type terminals, shall be rated to accept
gauge of wire to be terminated. 

No more than 2 cables shall terminate in each screw type terminals. Where more than 2 cables are required to terminate at the same point, additional termination blocks shall be added to conform to the 2 cables per termination point.

Marrette type connectors shall not be used. Connectors shall be crimp connectors.

Install, the wiring system and integrate the system as indicated in this specification. Where information is not available from the University of Toronto upon request, the worst-case condition must be assumed to ensure a complete, functional system.

End-of-line resistors shall be located at the device. End-of-line resistors shall not be located in termination panels.

Install wire parallel and square with building lines, including raised floor areas.

Protect cable ends at all times with acceptable end caps except during actual termination.

Coaxial cable shall not be subjected to any bend less than a 150mm (6”) radius.

The Cables for PTZ control shall not be daisy-chained.

All field installed BNC connectors to be type 3-piece-crimp or Compression fit connectors. Twist-on connectors are not acceptable.

Provide communications wiring UTP or fibre optics cable for connection to the University Campus Police monitoring system. Termination hardware and patch panels shall be provided in coordination with the University.

Fibre optic cable shall not be subjected to any bend of less than a 200mm (8”) radius.

Fibre optic cable shall be provided with guides and tie-downs on termination boards so that when terminated to the transmitter or receiver, each individual fibre shall be protected from inadvertent movement or impact that would exceed design tolerances and potentially damage the fibre.

Protect wire and cable from kinks.

Provide grommets and strain relief material where necessary, to avoid abrasion of wire and excess tension on wire and cable.

All card readers shall be wired with a cable with a minimum of 6 conductors, excluding any grounding conductors.

All network cabling to be provided as shown on the contract drawings shall be a minimum of Cat5e.

Testing

Test for ground loops that may result from use of different power sources for various components.

All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.

After installation, and before termination, all wiring and cabling shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields. All test results shall
be documented and submitted with the as-built documentation. Visually inspect wire and cable for faulty insulation prior to installation.

**Identification And Tagging**
Refer to Section 16700

End of Section
16710 Access Control Systems

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Related Work
Comply with relevant Sections of this and other Divisions as required.

Overview
All burglar and the PCSC Fault Tolerant door access system hardware and software must be 100% compatible and fully integrated with the EBI system software installed by Honeywell and operated by the University of Toronto Police.

The University has already purchased and installed the EBI server software, database and completed installation of door access hardware components at existing campus locations.

Installation of additional door access system components must fully meet the specifications of the existing EBI installation and integrate seamlessly with that system.

The access control system shall allow for interfaces with other systems including, but not limited to, the burglar alarm, intercom, fire and CCTV systems.

The burglar alarm system shall allow for interfaces with other systems including, but not limited to, the access control, intercom, fire and CCTV systems.

The burglar alarm system hardware and software must be 100% compatible and fully integrated with the EBI system software installed by Honeywell and operated by the University of Toronto Police and/or to the FBII CP220 Central Station Receiver.

Fault Tolerant Access Control System Specifications:
The access control system must be capable of performing the following tasks with the EBI system:

Allow or deny the unlocking of a locked entrance based on criteria established in the software for individual cardholders.

Record a log file of all system activity, including door access granted and denied, alarms, system messages, and data maintenance.

Allow monitoring of the overall system for functionality and alarms from multiple points. System will require and record alarm acknowledgments by operator.

Utilize the campus TCP/IP network for communications between controllers and the central database.

Provide security of the door, even in the event communication is lost to the main database,
allowing the door to continue to recognize which cards to grant access to, and continuing to record access transactions.

Allow proper egress in emergency situations such that no special knowledge or card is required to exit a space.

Must comply with OBC and other standards of the campus.

Provide for a Guard Tour feature to record the rounds of security personnel, including alarming if a guard check-in is overdue or missed.

Allow for central administration of the access control database for purposes of populating and maintaining the overall database, while allowing numerous secured users to grant or deny access for individuals from multiple workstations around the campus.

Allow for unattended scheduled unlocking of individual doors for a sustained period of public access.

System capability (as part of its own application), to digitally record cameras associated with alarm events as well as pre and post alarm images, with the ability to review the camera images as part of the alarm log on the workstation. The digital video recording would take place on separate networked recording units with video capture devices allowing for up to 16 cameras recorded per computer. It must be possible to select video files by, date or range of dates, and by the hour or hour range, or by the video file name, as well as in association with an alarm event.

System capability to view live video on any workstation via the network or through a separate video input to the computer.

The main system must be an on-line type system, where data is exchanged between the central server and the readers via the campus network and other wiring.

The system must fully and completely integrate with the EBI door access system manufactured by Honeywell.

PRODUCTS

Access Control System

The access control system will be a PCSC Fault Tolerant system consisting of SDM (single door reader) and DDM (double reader doors) controllers and a Main Controller.

FT Main Controller
- Automatic hot cutover
- fail safe operations
- open system platform
- open architecture protocol
- Ethernet/PoE communication
- peer to peer communications
- auto alternate communication routing
• access action for disabled persons
• onboard rechargeable battery circuit
• user selectable input monitoring modes

The SDM FT Controller (located at the door) has the following features:
• 32 Bit CPU
• onboard PoE communication
• 1 Weigand Reader port
• 1 door lock form C relay output
• 1 Rex Input
• 1 door position input
• 1 powered lock output

The DDM FT Controller (located in a locked room) has the following features:
• 32 Bit ARM Processor and Architecture
• on board Ethernet communication
• PoE connection
• Flash memory
• 3 communication ports
• Seven segment status display
• Host online notification
• tamper
• Battery charger output
• electronically Protected power input
• 5 state alarm monitoring
• 2 Weigand reader ports
• 2 door lock form C relay outputs
• 2 Rex Inputs
• 2 door position inputs
• 2 alarm shunt outputs
• 4 voltage outputs
• 4 sense inputs
• powered lock output

The controllers shall be fitted with memory expansion to handle a minimum of 25,000 cardholders.
Upgrade modules shall provide supervised inputs. Non-supervised input modules shall not be used.
Elevator access controls DGP’s shall be PCSC IQ ELV series controllers.
Control panels shall be within a key locked enclosure with a tampered cover to be monitored as a separate input.

**Proximity Cards/Fobs**
HID iClass Cards and Fobs will be supplied by the University

**Card Readers**
Card Readers, where wall mounted, shall be HID iClass R40 Proximity card readers.
Card readers shall be wired to ensure that the panel supervises the reader. It is the contractor’s responsibility to ensure that the proper number of cables are supplied to provide this supervision if the number of conductors specified is insufficient for the proper installation.
Card readers, where installed beside the doors or on mullions, shall be HID iClass R10 Proximity card readers.
Doors surrounded by glazing shall have mullion mounted card readers.
Audible alert integral to the card reader shall be connected and shall annunciante when the door is in both “Door Held Open” and “Door Forced Open” alarm conditions.
Request to Exit (REX) will be in the handle or push bar of the lock.
In exceptional circumstances and only with the written approval of the manager, security systems, a REX may be installed above the door on the secure side as below.
REX motion detectors shall be passive infrared technology and equipped with an adjustable relay timer, a cover tamper switch and an adjustable vertical and horizontal area of detection.
REX motion detectors shall be Kantech T-Rex model #T.REX-LT or approved equal.
REX motion detectors shall be monitored as a separate input and shall not be interconnected to the door contacts to be bypassed so that the request to exit is a controller-based decision.
Detectors shall have a tampered cover that is monitored as a separate input unless using the PCSC FT SDM or other controller that is not equipped with an extra input.

**Door Contacts (Person Doors)**
Door contacts shall be Sentrol 1078T 1” door contact or approved equal.
All door contacts shall be concealed unless otherwise approved by the consultant.
Door contacts shall be of a colour to match the colour of the doorframe where possible. This information must be provided at the design stage or the standard white contacts will be provided

**Door Contacts (Overhead Doors)**
Door contacts shall be Sentrol 2200 Series door contact or approved equal.

**Key Switch Bypass (Overhead Doors)**
Key switch bypass shall consist of a tubular key and a lock switch that is maintained ON/OFF
(DISARMED/ARMED) with the key removable only in the OFF (ARMED) position.
Key switch shall be monitored as a separate input and shall not be interconnected to the door
contacts to be bypassed so that the bypass is a controller-based decision.

**Motion Detection (Interior Area Protection)**
Motion detectors shall be dual technology consisting of both passive infrared and microwave
technologies and shall be Honeywell Dual Tec Series detectors or approved equal.
Detectors shall have a tampered cover that is monitored as a separate input.
Detector model maximum coverage area shall be suitable to cover intended area unless
otherwise specified.

**Glass Break Detectors**
Glass break detectors shall be acoustic technology with a maximum range of 15 feet and shall
be Honeywell FG-1625 Glass break or approved equal.
Glass break detectors shall be tested and approved for installation with 3M security window
film.
Glass break detectors shall be mounted between 10ft to 12 feet from the windows they are
intended to protect.
Detectors shall have a tampered cover that is monitored as a separate input.

**Duress Buttons**
Duress buttons are not used on the St. George Campus.

**Electrified Locking Devices (Door Hardware)**
All electrified locking devices shall be fail secure devices and shall be wired in a fail secure
manner during a panel and/or power failure.
When using the PCSC FT SDM, lock status is not monitored. With the approval of the Manager,
Security systems and Services, in high security applications, electrified locking devices shall be
fitted with lock status monitors and monitored as a separate input.
Doors equipped with a mechanical or electrical crash bar/panic set shall have a request to exit
switch integral to the door hardware. Doors with all other types of locking hardware shall
incorporate a Request to Exit Motion Detector.
The University standard is to supply crash bars/panic sets on all exterior doors unless otherwise
specified.
All hardware not supplied by the University of Toronto shall conform to the University of
Toronto Door Hardware standards.

EXECUTION
General Responsibilities and Requirements
The quantities of components shall be determined and installed by the Security System Contractor based on the requirement to provide a fully operational Security System, as per the intent of the specification, and as shown on the drawings and recommended by the manufacturer.

Controllers shall be filled to a maximum of 75% of the maximum card reader capacity to allow for future expansion. Required inputs and outputs for each spare reader port to complete fully functional access door, as described in the specifications, are to be left spare as well.

All hardware mounted in exterior locations must be weather resistant and designed to maintain the aesthetic beauty of the campus.

Hardware must be durable enough to withstand high traffic locations without frequent failure.

Devices must be hardwired, with all wiring installed in conduit in accordance with written university standards for access system installation. The conduit system and cabling installed must be distinct and separate from the wire way/conduit system housing other systems cables in campus buildings.

Connections to devices must be secured, so that no cords may be easily disconnected from the devices and no cords are left exposed to unauthorized tampering.

The access control panels shall operate on TCP/IP communications protocol unless otherwise noted on the contract drawings that RS-485 communication may be implemented.

The Ethernet communication configurations shall be standard.

All control panels shall operate in local and remote configurations.

When allowed, RS-485 multi-drop total distance shall be 4,000 feet with a maximum of 16 control panels, without the use of modems or line drivers. If installation requires distances greater than listed above, a line driver or modem shall be used, after approval by the consultant.

All control panels shall provide a 12 VDC back-up battery for up to four hours of operation upon loss of AC power. The control panel shall provide a super capacitor to retain database information for up to seven days upon loss of power.

All controllers shall be equipped with the most current firmware available at the time of substantial completion.

All visible or easily accessible screws shall be tamper proof.

When centralized control panels are used, inputs shall employ double end of line resistors.

System Design
All doors deemed as entry and/or exit doors shall be equipped with, as a minimum, an electrified locking device, door contact and a request to exit signaling device.

All entry and exit doors shall report both door forced open and door held open alarms.

All access control doors shall be equipped with a University supplied key override, so that in the event of a system failure access can be obtained.
All elevators shall be equipped with a card reader to allow/restrict access to all floors to allow the elevator to be locked down remotely. Floor monitoring is not required.

No interconnecting of devices will be allowed unless otherwise specified. All decisions shall be controller based.

Overhead doors are to be equipped with a door contact and key switch bypass.

Lock power and control panels are to have separate power supplies.

All power supplies are to be sized to accommodate the equipment to be powered and shall conform to manufacturer’s installation recommendations.

Power supplies shall be loaded to 70% of the available ampacity of the power supply unless specifically designed for a single device to be connected to the power supply.

It is the contractor’s responsibility to provide all interconnection and wiring to existing equipment already installed on site including, but not limited to, auto door openers and actuator buttons.

Doors with auto openers shall be interfaced so that the locking device is disengaged (unlocked) prior to the auto door opener attempting to open the door so as to avoid motor burnouts.

Burglar panels shall be able to be programmed to transmit alarm information in Contact I.D. format.

End of Section
16711 Surveillance System

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Related Work
Comply with relevant Sections of this and other Divisions as required.

Overview
All Surveillance system hardware and software must be 100% compatible and fully integrated with the HDVM system software installed by Honeywell and operated by the University of Toronto Police.

The University has already purchased and installed the EBI server software, database and completed installation of camera hardware components at existing campus locations.

Installation of additional Surveillance system components must fully meet the specifications of the existing HDVM installation and integrate seamlessly with that system.

The Surveillance system shall allow for interfaces with other systems including, but not limited to, the access control, burglar alarm, intercom, and fire systems.

Each building shall be designed as a stand-alone system with a HDVM server and software supplied by the University and sized to accommodate the number of cameras to be installed. The server will be connected to the Private Security Network so that the University of Toronto Police may view selected video over the network.

Sites with a single camera to be installed may be connected to the main HDVM system by approval of the University of Toronto Police only.

Signs will be provided to the project by Campus Police (St. George Campus) and must be erected in the area where video surveillance is being conducted. No other sign may be used and no camera may be mounted without prominently displaying the sign.

PRODUCTS

Overview
The CCTV system shall be designed and installed such that no tearing, rolling or distortion is observed on any monitor. There shall be no degradation of this requirement when the system operates through the video switcher / controller.

Cameras installed with light fixtures or similar bright objects in the field of view shall not exhibit blooming or any loss of overall picture quality.
Under normal operating conditions, the overall system performance shall meet or exceed the following minimum requirements:

- Signal to noise ratio: 50 dB
- Cross Modulation Index: 50 dB
- R.F. Isolation (Between Video Circuits): 50 dB
- Non-Linearity: Less than 5%
- System Resolution: 1280 by 960 to 160 x90

All equipment and materials used shall be standard components that are regularly manufactured and utilized in the manufacturer's system.

All cameras and housings within a site/building shall be from a single manufacturer and the aesthetics of all cameras installed within a site/building shall be similar.

**Manufacturers**

Cameras shall be manufactured by:

- AXIS
- Honeywell
- Lenses shall be manufactured by:
  - Axis Communications

**Video Servers**

- Video servers shall have following capabilities:
  - Transmit high quality video at a rate of 20 frames per second in all resolutions
  - Resolution options up to 1280x960 min. and numerous compression levels.
  - Support for PTZ units.
  - Video servers shall be Axis Q74 for a single camera for up to 16 cameras.

**Lenses**

Lenses for cameras that are not part of an integral camera and housing package shall be varifocal lenses with remote focus and zoom, P iris control, IR corrected, megapixel resolution and sized to fit the intended field of view.

**Fixed Surveillance Domes (indoors)**

The Axis P33 Network cameras shall have Lightfinder technology, Wide Dynamic Range-capture, built in IR Illumination, P-Iris control.

Models include:

- P3365V-2 MP
- P3346V
- P3384V-3 MP
**Image Sensors:**
P3354/P3364-V/P3364-LV/P3384-V progressive scan

**Lens**
Varifocal, remote focus and zoom, P-Iris control, IR corrected, megapixel resolution.
P3354/P3364-V/P3364-LV 6 mm; 2.5-6mm, 105-49 view, F1.2
P3354/P3364-V/P3364-LV 12 mm; 3.3-12mm, 82-24 view, F1.4
P3384-V/P3346/P3346-V/P3367-V; 3-9mm, 84-30 view, F1.2
P3365-V; 3-9 mm, 100-35 view, F1.3

**Minimum Illumination**
0.08 lux

**Video Compression**
H.264 Baseline and Main profile (MPEG-4 Part 10/AVC, Motion JPEG

**Resolution**
P3354/P3364-V/P3364-LV/P3384-V 1280x960 –approx.1.3 MP to160x90
P3365-V; 1920x1080-2MP to 160x90
P3346/P336-V: 2048X1536 -3MP to160-90
P3367-V: 2592 x 1944 -5 MP to 160x90

**Frame rate**
P3354/P3364-V/P3364-LV/P3365-V/P3384-V 25/30fps with power line frequency 50/60
P3346/P3346-V: 3MP capture mode: 20fps in all resolutions, HDTV 1080p (1920x1080 and 2MP 4:3 1600x1200 capture modes: 30 fps in all resolutions.
P3367-V: 5MP capture mode: 12 fps in all resolutions and capable of all P3364/-V capture modes.

**Video Streaming**
Multiple, individually configurable streams in H.264 and Motion JPEG. Controllable frame rate and bandwidth VBR/CBR H.264.

**Pan Tilt Zoom (PTZ) Interior Cameras**
The product specified shall be a high speed domed camera system available in pendant or suspended ceiling mounted versions designed for indoor surveillance applications. The camera system consists of an integrated color CCD camera with a 1/4-inch imager and a 16X (4.1 mm-65.6 mm) auto-iris, auto-focus zoom lens; a variable/high speed, 360° pan/tilt unit; and an intelligent, integral receiver/driver. This camera system is compatible with the Philips/Bosch
Allegiant series switcher/controller and the System4 Video Management System.

The camera shall accept Philips/Bosch Biphase camera control codes or customer programmed control code protocol via an RS232 input.

The camera shall provide a Fast Address feature to allow the camera address number to be remotely programmed from the system keyboard without the need to set address dip switches in the camera. The camera shall be compatible with the Philips/Bosch Allegiant Switcher/Controller having CPUs version 5.2 or newer and controlled via Philips/Bosch variable speed keyboards.

The camera shall be equipped with an 16x optical zoom lens.

To ensure optimal zoom control, the camera shall provide a scaling function that automatically adjusts the speed of the pan or tilt movement dependent upon the field of view of the lens. When the zoom lens is set for wide angle field of view, the joystick of the controller keyboard will allow the speed of the pan and tilt to operate faster than when the lens is set to a narrow zoomed in field of view. Slower pan and tilt speeds when the lens is zoomed in provides for more controlled target tracking by the operator.

The camera’s 360° pan rotation shall be divided into 16 independent sectors. Each sector may be titled with up to 16 characters. Any or all of the 16 sectors may be blanked from the operator’s view when viewing restrictions are required.

The camera shall allow the storage of up to 99 preset scenes with each preset programmable for 16 character titles. A tour function shall be available to consecutively display each of the preset scenes for a programmed dwell time. Any or all of the presets may be included in or excluded from the tour.

The camera shall be capable of recording two (2) separate tours of an operator’s keyboard movements consisting of, tilt, and zoom activities for a total combined duration time of 15 minutes. Recorded tours may be continuously played back.

When an operator stops manual control of the camera, and a programmed period of time is allowed to expire, the camera will execute one of the following programmable functions:

- return to preset #1
- return to the automated tour previously executed
- do nothing.

The camera shall ensure that any advanced commands required to program the camera are accessed via three levels of password protection ranging from low to high security.

The camera system shall provide a feature that automatically rotates, or pivots, the camera to simplify tracking of a person walking directly under the camera.

The camera shall be supplied as standard product with a tinted viewing bubble, but an optional clear viewing bubble shall be available as required by the application.

The camera shall be offered in suspended ceiling or pendant mounted versions as required by the application.

The pendant mounted versions shall be available in white or charcoal colors. Wall mount and pipe mount kits shall be available for pendant mounted units.
EXECUTION

**General Responsibilities and Requirements**

Supply and install all fittings and accessories, whether or not they are specified, required for proper, safe and reliable operation of the system.

A preposition shall be programmed for every alarm trigger that is visible in the field of view of the camera.

All fields of view shall be approved by the Owner and/or the Owner’s Representative prior to final testing.

End of Section
16712 Intrusion Systems

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Overview
All burglar and door access system hardware and software must be 100% compatible and fully integrated with the EBI system software installed by Honeywell and operated by the University of Toronto Police.

The University has already purchased and installed the EBI server software, database and completed installation of door access hardware components at existing campus locations.

Installation of additional door access system components must fully meet the specifications of the existing EBI installation and integrate seamlessly with that system.

The access control system shall allow for interfaces with other systems including, but not limited to, the burglar alarm, intercom, and fire and CCTV systems.

The burglar alarm system shall allow for interfaces with other systems including, but not limited to, the access control, intercom, and fire and CCTV systems.

The burglar alarm system hardware and software must be 100% compatible and fully integrated with the EBI system software installed by Honeywell and operated by the University of Toronto Police and/or to the FBII CP220 Central Station Receiver.

PRODUCTS

Intrusion System Specifications
The control panel shall be the ADEMCO VISTA-128BPT Commercial Burglary Partitioned Security System or equivalent.

System performance
Control Panel - The control panel shall be an eight (8)-partition, UL commercial burglary control panel that supports up to 128 zones using basic hardwired, polling loop, and wireless zones. It shall also provide supervision of the bell output, RF receivers, and relay modules. In addition, the control shall provide the ability to schedule time-driven events, and allow certain operations to be automated by pressing a single button. The system shall be capable of interfacing with an ECP long range radio (LRR) unit that can send Contact ID messages, and alphanumeric paging devices. The control shall provide integrated access control and CCTV -switching capability.

Basic Hardwired Zones - The control shall provide nine (9) hardwired zones with the following
characteristics:

- EOLR supervision (optional for zones 2-8): Shall support N.O. or N.C. sensors (EOLR supervision required for UL installations).
- Individually assignable to one of eight (8) partitions.
- Supports up to 16 two-wire smoke detectors on one selected zone.
- Supports four-wire smoke or heat detectors on any zone (power to four-wire smoke detectors must be supervised with an EOL device).
- Supports up to 50 two-wire latching glass break detectors on one selected zone.

Optional Expansion Zones

Polling Loop Expansion - The control shall support up to 119 additional hardwire zones using a built-in two-wire polling (multiplex) loop interface. The polling loop shall provide power and data to remote point modules, and constantly monitor the status of all zones on the loop. Maximum current draw shall not exceed 128 mA. The polling loop zones shall have the following characteristics:

- Interface with RPM (Remote Point Module) devices.
- Individually assignable to one of eight (8) partitions.
- Supervised by the control panel.
- A 12,000 ft. (3658 m.) wire runs capability without using shielded cable.
- Each RPM (Remote Point Module) enclosure shall be tamper protected.

Wireless Expansion - The control shall support up to 128 wireless zones using a 5800 series RF receiver (fewer if using hardwire and/or polling loop zones). Wireless zones shall have the following characteristics:

- Supervised by control panel for check-in signals (except certain non-supervised transmitters).
- Tamper-protection for supervised zones
- Individually assignable to one of eight (8) partitions.
- Supports wireless devices listed for Commercial Burglary using the 588IENHC RF Receiver.

Partitions - The control shall provide the ability to operate eight (8) separate areas, each functioning as if it had its own control. Partitioning features shall include:

- A Common Lobby partition (1-8), which can be programmed to perform the following functions:
- Arms automatically when the last partition that shares the common lobby is armed.
- Disarms when the first partition that shares the common lobby is disarmed.
- A Master partition (9), used strictly to assign keypads for the purpose of viewing the status of all eight (8) partitions at the same time (master keypads).
User Codes - The control shall accommodate 150 user codes, all of which can operate any or all partitions. Certain characteristics must be assignable to each user code, as follows:

- Authority level (Master, Manager, or several other Operator levels). Each User Code (other than the installer code) shall be capable of being assigned the same or a different level of authority for each partition that it will operate.
- Opening/Closing central station reporting option.
- Specific partitions that the code can operate.
- Global arming capability (ability to arm all partitions the code has access to in one command).
- Use of an RF (button) to arm and disarm the system (RF key must first be enrolled into the system).

Peripheral Devices - The control shall support up to 30 addressable ECP devices, which can be any combination of keypads, RF receivers, relay modules, annunciator modules, and interactive phone modules. Peripheral devices have the following characteristics:

- Each device set to an individual address according to the device's instructions.
- Each device enabled in system programming.
- Each device's address shall be supervisable (via a programming option).

Keypad Annunciator - The control shall accommodate up to 16 keypads or six (6) touch-screen (i.e., advanced user interface) keypads. The keypads shall be capable of the following:

- Performing all system arming functions.
- Being assigned to any partition.
- Providing four programmable single-button function keys, which can be used for:
  - Panic Functions - activated by wired and wireless keypads; reported separately by partition.
  - Keypad Macros - 32 keypad macro commands per system (each macro is a series of keypad commands). Assignable to the A, B, C, and D keys by partition.

Optional Output Relays - A total of 96 relay outputs shall be accommodated using relay modules. Each relay module shall provide four (4) Form C (normally open and normally closed)
relays for general purpose use or two (2) supervised notification appliance circuit outputs, when using the 4204CF module. The relays shall be capable of being:

- Programmed to activate in response to system events.
- Programmed to activate using time intervals.
- Activated manually.
- Assigned an alpha descriptor.
- Used for supervised bell outputs (4204CF module).
- A combination of 4204 (ECP) and 41O1SN (polling loop) relays.

Optional Vista Interactive Phone Module - The control shall support the ADEMCO 4285/4286 VIP Modules, which permit access to the security system in order to perform the following functions:

- Obtain system status information.
- Arm and disarm the security system.
- Control relays.

Optional LED Annunciator - The control shall support the ADEMCO FSA-8 and FSA-24 annunciators, which are capable of:

- Visually identifying a zone or point that is in alarm or trouble.
- Programmable for system silence/reset.
- Up to 96 LEDs may be used in one system.
- A total of four (4) FSA-24 or 12 FSA-8 annunciators may be used in one system.
- An optional keys witch, FSAKSM module, shall be available for UL listed Silence and Reset capability.

Integrated Access Control - The control shall be capable of the following:

- Providing a command that activates relays to allow access doors to open (e.g., lobby door), lights to be turned on or off, etc.
- Becoming a fully integrated access control system by using numerous Vista Key Single-Door Access Control Modules.
- Supporting up to eight (8) VistaKey Access Control Modules. The Vista Key Access Control Modules shall use the same Compass Downloader as the Vista- 128BP and shall be programmable from the Compass Downloader or the Keypad Annunciators.
- Assigning any number of access control relays to each partition (up to 96 for the system).
- Supporting up to 250 access card holders using Vista Key.
- Connecting to the ADEMCO Pass Point Access Control System via the Vista Gateway Module (VGM).

CCTV Switching - The System shall be capable of supporting the Vista View 100 CCTV Switching
System. The CCTV system shall be fully integrated and be event driven by Fire, Burglary or Access events. When cameras are not event driven, they shall be driven by an automatic preset dwell time. The system shall also be capable of:

- Activating the CCTV system via a Form-C relay output.
- Operating up to 60 camera inputs and 30 video outputs.

Commercial Wireless Equipment - The Control shall be compatible with UL Listed Commercial Wireless Fire & Security equipment including:

- ADEMCO 5881ENHC Commercial Fire/Burg Receiver - The receiver shall be capable of receiving as many points as the control panel is rated for. Up to two (2) Receivers may be used on any system. Receivers may be remotely located anywhere on the system Keypad/Annunciator bus.
- ADEMCO 5808LST Wireless Photoelectric Smoke and Heat Detector - The device shall be UL 268 listed.
- ADEMCO 5809 Wireless 135D Fixed Temperature and Rate of Rise Heat Detector - The device shall be UL 521 listed for commercial applications.
- ADEMCO 5817CB Wireless Universal Contact Monitoring Transmitter - This device shall be capable of making any conventional UL listed contact device a wireless device. The device shall be UL listed as follows: UL 985 for fire and UL 365, 609, 1023, 1076 and 1610 for security and nurse call.
- ADEMCO 5869 Wireless Hold Up Switch/Transmitter - This device shall be UL 636 listed for commercial burglary applications.

Optional Key switch - The control shall support the ADEMCO 4146 Key switch on anyone of the system's 8 partitions. If used, zone 7 is no longer available as a protection zone.

Voltage Triggers - The system shall provide voltage triggers, which change state for different conditions. Used with LRR (Long Range Radio) equipment or other devices such as a remote keypad sounder, keyswitch ARMED and READY LEDs, or a printer to print the system's event log.

Event Log - The System shall maintain a log of different event types (enabled in programming). The event log shall provide the following characteristics:

- Stores up to 512 events.
- Viewable at the keypad or through the use of Compass software.
- Printable on a serial printer using a 41 OOSM Module including zone alpha descriptors.
- Stores Pass Point access control events.
- Sends printed events to up to eight alpha numeric pagers.

Scheduling - Provides the following scheduling capabilities:
- Open/close schedules (for control of arming/disarming and reporting).
- Holiday schedules (allows different time windows for open/close schedules).
- Timed events (for activation of relays, auto-bypassing and un-bypassing, auto-arming and disarming, etc.).
- Access schedules (for limiting system access to users by time)
- End User Output Programming Mode (provides 20 timers for relay control).
- The system shall automatically adjust for daylight savings time.

Communication Features - Supports the following formats and features for the primary and secondary central station receivers:

Formats
- ADEMCO Low Speed (Standard or Expanded).
- Sescoa/Radionics.
- ADEMCO Express.
- ADEMCO High Speed.

ADEMCO Contact ID. Backup reporting - The system shall support backup reporting via the following:
- Secondary phone number.
- ECP long range radio (LRR) interface
- Option to select long range radio (LRR) or dialup as the primary reporting method (dynamic signaling feature)

Internet reporting - The system shall be capable of communicating with the central station via the internet using Alarmnet-i. It shall provide the user with the ability to control the system via a browser interface (i.e., AOL, Netscape, and Internet Explorer). All packet data transmitted to the monitoring station shall be encrypted with a minimum of 1024 bits of encryption.

Audio Alarm Verification Option - Provides a programmable Audio Alarm Verification (AAV) option that can be used in conjunction with an output relay to permit voice dialog between an operator at the central station and a person at the premises.

Cross-Zoning Capability - Helps prevent false alarms by preventing a zone from going into alarm unless its cross-zone is also faulted within 5 minutes.

Pager Interface - The Control Panel shall be capable of sending event information to an alphanumeric pager via a V A-8201 pager interface device.

Exit Error False Alarm Prevention Feature - The System shall be capable of differentiating
between an actual alarm and an alarm caused by leaving an entry/exit door open. If not subsequently disarmed, the control panel shall:

• Bypass the faulted E/E zone(s) and/or interior zones and arm the system.
• Generate an Exit Error report by user and by zone so the central station knows it was an exit alarm and who caused it.

Built-in User's Manual and Descriptor Review - For end-user convenience, the control panel shall contain a built-in User's Manual. It shall include the following capabilities:

• By depressing any of the function keys on the keypad for five (5) seconds, a brief explanation of that function shall scroll across the alphanumeric display
• By depressing the READY key for five (5) seconds, all programmed zone descriptors shall be displayed (one at a time). This feature shall provide a check for installers and ensure all descriptors have been entered properly.

Programming - The Control shall be capable of being programmed locally or remotely using the ADEMCO Compass Downloader and shall be capable of:

• Uploading and downloading all programming information at 300 baud.
• Uploading and displaying firmware revision levels from the control.

Panel Linking - The Control shall be capable of being networked together with up to eight other controls and being operated by any keypad within the system. It shall provide the ability for users to:

• Control multiple zones, partitions, and/or buildings from a central location.
• Check status, arm and disarm any partition from any keypad in the system.
• Globally arm or disarm partitions based upon user authority.

Automation Software - The Control shall be capable of interfacing with automation software via an RS232 input on a single partition.

Keypads
Keypads shall be Touch Screen Vista 6280 Keypads.

Door Contacts (Person Doors)
Door contacts shall be Sentrol 1078T 1” door contact or approved equal.
All door contacts shall be concealed unless otherwise approved by the consultant.
Door contacts shall be of a colour to match the colour of the doorframe where possible.

Motion Detection (Interior Area Protection)
Motion detectors shall be dual technology consisting of both passive infrared and microwave.
technologies and shall be Honeywell Dual Tec Series detectors or approved equal. Detectors shall have a tampered cover that is wired into the monitored circuit as to cause a trouble condition on the circuit when triggered. Detector model maximum coverage area shall be suitable to cover intended area unless otherwise specified.

Glass Break Detectors
Glass break detectors are recommended wherever there is a glazed area in close proximity to a lock or windows are easily accessible from the exterior. Glass break detectors shall be acoustic technology with a maximum range of 15 feet and shall be Honeywell FG-1625/T Glass break or approved equal. Glass break detectors shall be tested and approved for installation with 3M Security window film. Detectors shall have a tampered cover that is wired into the monitored circuit as to cause a trouble condition on the circuit when triggered.

High/Low Temperature Sensors
Temperature sensors shall be TS-300 IntelliTemp with programmable alarm delay.

Water Sensors
Water sensors shall be Honeywell #470-12.

Siren
Siren shall be Honeywell WAVE.

EXECUTION

General Responsibilities and Requirements
The quantities of components shall be determined and installed by the Security System Contractor based on the requirement to provide a fully operational Security System, as per the intent of the specification, and as shown on the drawings and recommended by the manufacturer. Controllers shall be filled to a maximum of 75% of the maximum card reader capacity to allow for future expansion. All hardware mounted in exterior locations must be weather resistant and designed to maintain the aesthetic beauty of the campus. Hardware must be durable enough to withstand high traffic locations without frequent failure. Devices must be hardwired, with all wiring installed in conduit in accordance with written university standards for access system installation. The conduit system and cabling installed must be distinct and separate from the wire way/conduit system housing other systems cables in campus buildings.
Connections to devices must be secured, so that no cords may be easily disconnected from the devices and no cords are left exposed to unauthorized tampering.

The access control panels shall operate on TCP/IP communications protocol unless otherwise noted on the contract drawings that RS-485 communication may is to be implemented. The Ethernet communication configurations shall be standard.

All control panels shall operate in local and remote configurations.

When allowed, RS-485 multi-drop total distance shall be 4,000 feet with a maximum of 31 control panels, without the use of modems or line drivers. If installation requires distances greater than listed above, a line driver or modem shall be used, after approval by the consultant.

All control panels shall provide a 12 VDC back-up battery for up to four hours of operation upon loss of AC power. The control panel shall provide a super capacitor to retain database information for up to seven days upon loss of power.

All controllers shall be equipped with the most current firmware available at the time of substantial completion.

All visible or easily accessible screws shall be tamper proof.

All inputs shall employ double end of line resistors.

End of Section
16713 Code Blue System

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Related Work
Comply with relevant Sections of this and other Divisions as required.

Related Work
Comply with relevant Sections of this and other Divisions as required.

Overview

GENERAL DESCRIPTION
The unit shall be a vandal-resistant communications device that is a multi-functional, freestanding pedestal constructed of carbon steel, model CB 1-e from Code Blue Corporation, no substitutions. It shall include a high quality, hands-free communications device illuminated by a high intensity faceplate light and a powerful combination blue beacon/strobe light that serves to easily identify it from a distance.

CONSTRUCTION
The unit shall be a cylinder constructed of ASTM A500 seamless carbon steel structural tube, schedule 20, 12.75” outside diameter x 0.25” thick wall, at a height of 108” and weigh approximately 330 lbs.

The unit shall have an internal anchor base plate that is MIG welded 2” above the base and fabricated with a minimum of 0.50” thick A-36 grade steel plate. It shall have a 5” diameter center hole for electrical conduit access. The base plate shall have four oblong holes on an 8” circular bolt pattern for attachment.

An access door measuring 14” H x 9.64” W will be placed 10.94” from the bottom of the base to provide access for mounting to the anchor bolts and connectivity to electrical facilities. The opening shall have a cover plate, which mounts flush and is the same steel and radius as the unit. The cover plate shall fit into the opening and have a weather-resistant gasket. The cover plate shall be held in place by two ¼-20 x 1” countersunk proprietary fasteners.

Tamper resistant proprietary fasteners manufactured for Code Blue Corporation shall be used. It shall not be possible to acquire the custom-designed bit from any other source.

A recessed opening shall be cut at a point beginning 36.6” above the bottom of the unit. The opening shall be 15.1” tall at the forward edge and 12.8” tall at the rear edge, creating a 25-degree angle from the horizontal and an arc of 160 degrees in the face.

The opening shall be enclosed by a 7 gauge steel plate with a single opening for a
communication device.

MOUNTING
The unit shall be mounted onto four anchor bolts that are set .50” above the concrete. Standard 0.75” x 24” galvanized steel anchor bolts, nuts and washers shall be supplied. The concrete foundation shall measure 24” x 24” minimum and the anchor bolts shall protrude 6” from the foundation.

ELECTRICAL
All electrical components shall have a modular plug for easy service and replacement, and will be equipped with a fuse for protection from transient voltage conditions. Requires 1 ampere at 24V AC. Voltage options shall include: 12-24V AC/DC; 120, 240, 277 and 347V AC. The unit shall have the option for Power over Ethernet for connectivity to a VoIP network switch with 802.3af (minimum) capabilities. Requires the IP5000 phone for connectivity to ToolVox or SIP/IAX2 compatible VoIP system.

LIGHTS
LED Beacon/Strobe: Located in the dome top assembly with a rating of no less than 270 Lumens/92 candela, it shall have a factory-set flash rate of up to 375 flashes per minute and be programmable. A deep blue UV-rated polycarbonate prismatic refractor shall surround the LED Beacon/Strobe and be used to distribute the light in a horizontal pattern for maximum brightness and visibility. The communication device shall be factory programmed to activate the LED Beacon/Strobe for the duration of a call. The LED Beacon/Strobe shall be 5.10” tall and 5.50” in diameter. Faceplate light: LED will direct light onto the communications device and be vandal resistant. The opening shall measure 4.50” W x .50” H. The light shall have a lifetime of 100,000 hours and a rating of 100 Lumens.

COMMUNICATIONS
The unit shall have a speakerphone communication device. IP5000 - VoIP: Refer to the IP5000 Architect and Engineering Specification for further information. IA4100 - Analog: Refer to the IA4100 Architect and Engineering Specification for further information. The unit shall be capable of communicating via third party IP wireless and cellular devices, which can be housed within the unit. EIA/TIA, ANSI, CSA and BICSI cabling or similar standards shall be adhered to for proper
operation of devices connected to copper or fiber infrastructure.

FINISH
Four-coat paint process, with zinc-rich primer for corrosion resistance and baked-on polyurethane enamel for maximum gloss and shine.
Optional clear coating process available to provide additional environmental protection.
Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards: D2794 Direct and Reverse Impact, D523 Gloss @ 60 Degrees, D3359B Cross hatch Adhesion, D1654 Corrosion Creep, D714 Scribe Blisters and D714 Field Blisters.
The finish shall be available in 12 standard colors: Safety Blue, Safety Red, Safety Yellow, Midnight Blue, Gloss White, Gloss Black, Medium Bronze, Dark Bronze, British Racing Green, Cardinal Red, Bright Silver and Tiger Orange. Custom colors shall be available.
Minimum coverage thickness of 2.0 mils.

COMPLIANCE
- Americans with Disabilities Act (ADA) compliant
- UL 60950-1 and UL 2017 listed
- NFPA 72 Chapter 24 (2010) compliant
- Meets NEMA 4X and IP56 requirements

GRAPHICS
Engineering grade reflective vinyl for high visibility and legibility.
Standard 3.25” tall and 30” long graphics text offerings: Emergency, Assistance, Security, Courtesy, Police, Information or Help Point.
Standard graphics color offerings: Reflective White, Reflective Blue, Reflective Black, Reflective Green, Reflective Red and Reflective Yellow.
Custom text, length and color options shall be available.

OPTIONS
- Active Vent Solar Powered Fan for improved air flow
- Overhead Camera Mount
- 360° Public Address Speakers
- Night Charge® power system
- Mounting Rings for housing and mounting third party security and communication products

WARRANTY
The CB 1-e shall be warrantied against any defects in material and workmanship, under normal
use, for a period of 2 years from date of installation. If system is found by manufacturer to be defective within the warranty period, manufacturer shall repair and/or replace any defective parts, provided the equipment is returned to manufacturer.

MANUFACTURER
The Manufacturer shall be Code Blue Corporation. 800-205-7186, 259 Hedcor Street, Holland, Michigan 49423. www.codeblue.com. THERE ARE NO EQUIVALENTS.

TYPES AND LOCATIONS
- CB 2-s Signature wall mount – outdoors or exposed areas
- CB 4-s Signature Wall/pole mount – outdoor or indoor exposed areas
- IP1501 & IP2500-s VoIP Speakerphones – in areas other than Elevators Lobbies - VoIP Buildings.
- IA4100 Single Button Analogue Speakerphone – in Elevator Lobbies - Analogue or VoIP Buildings
- IA4100 Dual Button Analogue Speakerphone – in Elevator Lobbies – Analogue or VoIP Buildings
- IA500-s Single Button Analogue Surface mounted – in Analogue Buildings

Verify locations, finish, wording and colour with Campus Police.

TOOLVOX
Analogue or VoIP with standard 2 analogue line cards. To be determined in consultation with Telecommunications Services and Campus Police as part of the Campus Assist Devices program.

End of Section
16730 Security and Access Control System, Testing and Commissioning

GENERAL

Reference
Read and be governed by the Security System General Requirements Section.

Related Work
Comply with relevant Sections of this and other Divisions as required.

Overview
The purpose of this section is to describe the commissioning process specific to the security systems and equipment. This includes the card access system, door monitoring and locking system, intercom system, closed circuit television system, and control room console. All punch items must be resolved and finished prior to the Contractor calling for the formal testing.

The contractor, prior to final acceptance commissioning, shall test all system to ensure a functioning system.

The contractor shall be responsible to coordinate with all other trades required to complete system testing and final commissioning.

The contractor is responsible to report any deficiencies of equipment, not under the contract, that affect the function of the equipment installed under the security contract.

Test Equipment
The contractor shall provide all test equipment required to properly demonstrate a complete and functional system including, but not limited to:

Portable two-way radios

All proprietary test equipment. The manufacturer’s representative shall provide the equipment, demonstrate use of the test equipment and assist the commissioning agency in the commissioning process. Proprietary test equipment shall become the property of the owner upon completion of commissioning.

The Contractor shall perform all tests, furnish all test equipment and consumable supplies necessary and perform any work as required to establish performance levels for the system in accordance with the specifications.

Documentation
The contractor shall provide, prior to acceptance commissioning, final versions of all testing documentation for approval.

Documentation shall be completed by controller and include:
TESTING

The Owner and/or the Owner's Representative may stop testing/commissioning if it is deemed that the systems are not fully functional and require re-work.

All testing shall conform to Manufacturers recommendations for installation and testing.

When the Contractor has completed system tests to his/her satisfaction and when the system record documents, including drawings, operation and maintenance manuals, are complete, the Owner and/or the Owner’s Representative are to be notified in writing that the system fulfills the specifications and is ready for acceptance testing.

Upon satisfactory on-line operation of the system software, the entire installation including all subsystems shall be inspected. Each device shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response. The scope of the inspection work shall include, but not be limited to, the following:

Document all measured values and control settings for the system. These values and settings shall be recorded in the as-built drawings and shall be made available at the time of acceptance testing, following the indicated testing procedures.

Check each system including all inputs and outputs for compliance with the performance standards.

Function of all remote sensors for proper operations and testing of all wiring. The test shall include operating each device as it should operate in normal usage. No operations are to be simulated for this test.

Check each control and monitoring function from all origination points to all controlled locations for proper operation.

Adjust each piece of equipment as required for optimum quality and to meet the manufacturer's published specifications.

Establish tentative normal settings for all systems controls. All setup controls shall be adjusted for optimum system performance and shall be marked for reference.

Demonstrate the power-up and power-down procedure for each system.

All tests shall be documented by the Contractor and shall be witnessed by the Owner and/or the Owner’s Representative. Following the system test and inspection, the Owner and/or the Owner’s Representative shall prepare a list of any outstanding work, which must be completed by the Contractor prior to issuance of the certificate of substantial completion.

Upon receipt of the Contractor's written notice that all punch list items from previous
inspections are complete, the Owner and/or the Owner’s Representative shall re-inspect the work for final acceptance. The Contractor shall provide all test equipment, materials and personnel as required to assist in final acceptance.

The final acceptance test shall consist of the following:

The Contractor shall verify that all record documentation is complete.

The operation of all system and equipment shall be demonstrated by the Contractor to comply with the contract documents. Both subjective and objective tests may be required by the Owner and/or the Owner’s Representative to determine compliance with the specifications.

Upon completion of the re-inspection, the Owner and/or the Owner’s Representative shall either accept the system as being substantially complete or advise the Contractor of work not completed or obligations not fulfilled as required for final acceptance. If necessary, the entire procedure shall be repeated.

The inspections and tests may be suspended at the option of the Owner and/or the Owner’s Representative if it is their opinion that major components of the system are defective. The Contractor shall have personnel available at the job site to make adjustments and repairs and take corrective action during the tests.

The system shall be accepted as complete when all base contract work has been completed and all remedial work is performed and all documentation is complete, accurate and accepted, the Owner's personnel have received the specified training and the system passed final commissioning.

The Contractor shall retain complete logs of tests for inspection and review at any time after the testing has started. Upon final completion of system tests the log records shall be submitted.

Complete field tests shall be performed on all sub-systems. Each individual function shall be tested and proven correct in function and response a minimum of two times with not less than two month time between individual tests.

Provide the services of fully qualified technicians. Tests shall be performed after the system is adjusted and operating in accordance with specification requirements.

**Access Control/Burglar Alarm Testing**

Card access control and burglar system performance testing shall include, for each control panel:

Demonstrate the ability for the system to come back "online" after losing all power (except internal memory battery back-up).

Demonstrate system function under AC power loss.

Individual device/door testing to include:

2-second maximum response time on card readers shall be demonstrated.

Read range test for each card reader.

Valid/invalid card reads on each card reader.

Door Forced open alarms for each door contact.
Door Held open alarms for each door contact.
Valid exit test for each door.
Walk test of Request to Exit Motions to ensure proper coverage.
Alarm initiation of each interior/exterior protection device including, but not limited to, duress buttons, door contacts, motion detectors and glass-break detectors.
Open circuit and short circuit tests for each monitored device.
Door locking and unlocking by time schedule and operator command.
Elevator floor control for each floor by time schedule and operator command.
Call button control for each floor. One selection per card read.
Tamper alarms for all devices.

**Surveillance Testing**

Resolution Test - To measure camera resolutions, an EIA Standard Resolution Test Pattern shall be placed in front of the camera being tested. Observing the wedges of the pattern on a monitor and noting the reading at the point where the lines are no longer discernible shall measure the limiting resolution. Vertical wedges shall provide the measurement of horizontal resolution and horizontal wedges shall provide the measurement of vertical resolution from 200 to 800 lines. Resolution measurements shall be taken at different light levels since resolution will vary with the change in light level.

Gray scale responses shall also be measured with this chart. The gray scale shall provide a guide to measure the ability of each camera to differentiate shaded from black to white.

Sequence Camera Tests - Manually activate each camera via the system keyboard on a sequence monitor and on the alarm monitor. Set up an automatic sequence for all cameras based on 6 camera per each sequence monitor. Demonstrate different sequence rates and camera combination.

Quad Camera Test - Display the 4 dedicated camera inputs for each Quad system on the Quad monitors. Demonstrate blowing up any one of the camera Quad images to full screen. Demonstrate the same image and a different image displayed on the Quad monitor and also display on the alarm monitor.

Quad DVR Test - Demonstrate the Quad DVR's are recording all four images as seen on the monitors (and a full screen image).

Alarm Input Test - Demonstrate an alarm input from the Security Intercom Card Access System by projecting on the alarm monitor and recording on the Alarm DVR the camera image for the associated camera. This test must be performed with an individual standing at the respective card reader or intercom to verify field of view for each camera location. Perform the same alarm input test for all doors with door status switches.

Keyboard Control/PTZ Test - Demonstrate via the keyboard controls the pan, tilt, and zoom function for all PTZ cameras. Camera viewing shall include the entire zoom focal length for all areas.
Preposition Test - Demonstrate each pre-position location for each PTZ camera based on activation of alarms per the CCTV points list.

Low-Light Level Tests - Demonstrate exterior Surveillance coverage during diminishing daylight hours to verify scene illumination starting at dusk and proceeding at intervals of every 30 minutes until total darkness. Test shall include looking at areas of the parking lot, walkways and all buildings perimeter areas of high contrast and extreme low light level areas. Demonstrate recording these areas while a person is walking through the fields of view. Playback must be of a quality to identify the individual.

Integrated Test - Demonstrate a fully operational system test by activating simultaneous multiple alarms from the security systems for both the Quads and sequenced camera locations to verify proper system component integration. System operation test shall include acknowledgment of all alarms and a return to normal status.

ACCEPTANCE

Acceptance is based on the successful completion of the testing requirements and therefore not open for deficiency items. It is understood that the tests may be conducted over a period of time; therefore each test may be accepted individually. Final acceptance and release will be when all tests are completed and accepted. Failure of a test requires that a specific test be re-run but does not affect any test already accepted with the exception of the Integrated Test. Failure of the integrated test may require the retest of one or more individual tests.

The Contractor will carry sufficient costs to cover any retesting required.

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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.

The following changes to the previous release (May 2017) of this document have been made.

1. Current and future fibre installations are limited to single mode (SM) only; exceptions listed in 12.2.
2. Metric measuring units are used throughout the text. Imperial system units used where specified by OEM.
3. Fibre and UTP cable specifications updated. Voice cables excluded as class. Cables used in VoIP and united communications are data cables.
4. Chapters 8, 9, and 10 augmented in part of TC rooms design, finish, and grounding.
5. The term “predictive site survey” is replaced by “wireless design” and made mandatory. Standards and specifications for wireless installations have been updated, as well as the labeling convention.
6. Installation warranty requirements added (chapter 21).

2. **EMERGENCIES**

The successful contractor must make all of the crew members aware 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/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 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 #’s identified in the scope and drawings are accurate with the manufacturers. Also, the contractor’s responsibility is to ensure all locations & distances identified in these 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:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>ANSI/TIA-568-C.2</td>
<td>Balanced Twisted-Pair Telecommunication Cabling and Components Standard</td>
</tr>
<tr>
<td>ANSI/TIA-568.3-D</td>
<td>Optical Fiber Cabling and Components Standard, Ed. D, 10-2016</td>
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<td>ANSI/TIA-569-D</td>
<td>Telecommunications Pathways and Spaces</td>
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<td>ANSI/ICEA S-87-640</td>
<td>Optical Fibre Outside Plant Communications Cable</td>
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</table>
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. Existing surfaces must be restored and finished back to the original condition or better. Project/Property Manager (PM) to determine the appropriate 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/Property Manager (PM).**

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 break through 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 PM 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 PM before proceeding.

5.5 Patching and making good of coring is the responsibility of the contractor.
6. **KEY ACCESS**

Contractors will have 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.

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 PM 24 hours prior to the work being performed. The PM will arrange with the University’s Fire Marshall to have the local devises decommissioned prior to the start of work.

8. **BUILDING ENTRANCE FACILITY (refer to Fig. 1 and Fig. 2)**

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 10,000 square-foot area served. This is a secure, strategically located room for each University building with the following attributes:

8.1 The building entrance facility (BEF) shall be constructed with full height walls using steel studs with minimum 5/8 inch drywall.

8.2 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.

8.3 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.

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

8.5 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.

8.6 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.

8.7 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 C and the humidity is kept between 30 to 55% RH. Dust filters must be installed on all inflow air vents or ducts.
8.8 The BEF shall be equipped with a minimum of two standard nineteen inch (19") 44RU equipment racks securely bolted to the floor. A minimum 1m 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 telecommunications facilities in the BEF minimum clearances of 1m must be maintained and also conform to any applicable Canadian Electrical Code requirements.

8.9 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 PM.

8.10 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) IG. 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.

8.11 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 telecommunications rooms and shall terminate on a telecommunications 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 telecommunications main grounding bus bar (TMGB). Each telecommunications closet shall be provided with a telecommunications grounding bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility.

8.12 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.

8.13 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/Property Manager (PM). 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. **TELECOMMUNICATIONS ROOMS** (refer to Fig. 1 and Fig. 2)

9.1 For minimum Building Entrance Facility and Telecom (TC) room refer to Fig. 1. Additional TC room per floor is required if UTP Cat6 cable distance to a work area exceeds 55 metres.

9.2 The TC rooms shall be constructed with full height walls using steel studs with minimum 5/8 inch drywall.

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 TR'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.

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 TR 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 C and the humidity is kept between 30 to 55% RH. Dust filters must be installed on all inflow air vents or ducts.

9.8 The TR 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.

9.9 Refer to Typical Layout of 19’ Racks in BEF and TC below for an example of cable termination and active equipment placement in a TC equipped with two 19” racks.

9.10 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.

9.11 Electrical outlets should be 20A, 208V. Where cumulative power draw is expected to be under 1500W, use of 20A, 110V outlets is acceptable.

9.12 Grounding and bonding infrastructure meeting Canadian Electrical Code and ANSI/TIA 607 requirements shall be routed through all telecommunications rooms and shall terminate on a telecommunications grounding bus bar equipped to handle NEMA compliant grounding hardware. All metallic non-current-carrying conductive parts, including equipment racks, shall be appropriately grounded.

9.13 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.
9.14 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 PM. 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.
10. **ELECTRICAL**

**General**


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 will 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 is 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 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 90deg. elbows will be utilized and no more than 180° of bends will be permitted between pull boxes (example: two 45° bends plus one 90° bend). The minimum radius of curvature shall be 10 times the conduit internal diameter (ID).

11.5. In TRs the conduit shall be installed parallel to the backboard with a 90° 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 will be 30 metres. The pull box shall have a screw type cover not hinged. All pull boxes must 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 water tight.

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 it to be fished.

11.13. It must resist crushing pressures and must not collapse within normal bending limits.

11.14. It should have a 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 where ever 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 telecommunications 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 telecommunications rooms shall be wire cable tray or equivalent, no less than 6 inches wide in TR and 12 inches wide in BEF by 3.5 inches deep. Only fittings such as sweeping 30, 45, 60, and 90 degree elbows, tee's 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 section of tray together to create right angle turns is not acceptable. Any custom alterations to the tray must be approved by the PM 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)**

12.1. Inter-building cables are copper and singlemode (OS2) 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 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 Category 3 unless otherwise specified by the project scope of work or the PM.

**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.
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 telecommunication rooms within a building.

13.2. As a minimum, the building backbone infrastructure should consist of at least 12 strands singlemode cable between each TR and the BEF. Multimode and/or UTP Cat6 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 telecommunications 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 inch spacing between rungs to support cables from the TR 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 conduit 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 CABLELING 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 telecommunications room.

14.2. Unless otherwise specified, at least two (2) blue jacketed Category 6 UTP four pair cable shall be installed from the rack-mounted modular patch panel in the TR's 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 telecommunications outlet by up to 3m 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 minor 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 telecommunications room to the wireless data outlet shall be two Category 6 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 telecommunications 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 m above the floor level. WAPs shall be mounted on the wall adjacent to the corresponding data outlets, where possible inside the drop ceiling. 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 above ceiling 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 6 specification.

17.3. Inter-building copper UTP cabling shall meet or exceed the ANSI/EIA/TIA Category 5 specification.

17.4. For the grounding of copper cable the contractor shall supply and install BIX/Cable output Cover and splice chamber. (CIRCA Part # 2100SBC-xx)

17.5. The contractor shall supply and install all necessary CIRCA TEL 3B1E Protector modules 5 pin black (xx per end)

17.6. The contractor shall supply and install ground wire from TBG 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 CIRCA protector, xx PR tail terminates on BIX 10A mount.

17.8. The contractor shall test as per TIA/EIA standards.

18. **FIBRE CABLE SPECIFICATIONS**

18.1. All inter building cable must be single mode (OS2) indoor/outdoor loose tube, dry water block, armoured cables with a water tight jacket and central strength member.

18.2. Legacy Multi-Mode cable (OM1) is allowed on horizontal runs within a building to support and/or maintain existing infrastructure.

19. **COMPONENT INSTALLATION**

19.1. All cable and components must be installed as per the manufacturer’s specifications.

19.2. 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.

19.3. For new installations only termination type excepted is a fusion splice. 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.

19.4. For repair of defective legacy equipment or adding panels to an existing enclosure field connectorization will be permitted.
19.5 Lubrication: if cable pulling lubricant is used for Fibre optic cable installation 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.

20. ‘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 format using industry recognized layering conventions and accompanied by two D size hard copies.

21. TESTING AND WARRANTY

21.1. 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 Variable) flat file. Hard copy test results must also be provided in the form generated by the test equipment or contractor produced with text file.

21.2. Submit to the University the fibre test tool calibration certificate.

21.3. The installation requires a 25 Year Warranty from the manufacturer. Contractor is to ensure that all registration and compliance are met based on their product selection. Cabling contractor must provide the owner a minimum one (1) year labour warranty.

Copper - 4 Pair

21.4. Provide full testing and documentation to satisfy Category 6 specifications. Test will be performed from the horizontal cable patch panel in the TR to the faceplate jack for all drop cables.
Copper - 25 Pair

21.5. Provide full testing and documentation to satisfy Category 5e specifications (or grade of cable installed). Tests will be performed from IDC connector strip to IDC connector strip for each four pairs.

21.6. 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)

21.7. Bi-directional attenuation tests 1310 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
22. LABELING

22.1 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

22.2 The legend on all drawings to show building and floor number. All drawings to be referenced as Data Plans
22.3 Each drawing will be prefixed with DPbbbbff - where bbbb is the building number, ff is the floor number

Example: DP012302

Building Identifiers

22.4 All of University of Toronto buildings are identified using the following format:
22.5 A three digit number preceded by either an 0 or A.

Example: 0123 or A123

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

Floor Identifiers

22.7 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

Telecommunications Rooms

22.8 All telecommunication rooms to be identified as TR xxxx-yyyy - where TR is telecommunication room, xxxx is the building identifier, yyyy is the floor identifier and z is the closet identifier, unique per floor.

Equipment

22.9 All equipment shall be identified in the format type-building-TR-number.
Example: F96-0038-01A-03 designates a 96 port fibre patch panel in building number 38 in telecommunications room A of the first floor and it is the third fibre patch panel there.

22.10 Consult the PM for equipment designations that should be used.

Inter-building Cable Identifiers

22.11 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.

Riser Cable Identifiers

22.12 Riser cables shall be identified in the format building-type-TRa-TRz-number.

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

Horizontal Cables

22.13 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.

22.14 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).

22.15 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 22.13) 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.
22.16 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.