

Part 1 Scope

- .1 Division 26 work on this contract includes supply, installation and field verification of the equipment indicated by drawings and referenced by specification sections. Selective demolition of existing supplemental lighting systems.
- .2 Co-operate and coordinate with the requirements of other units of work specified in other sections.

Part 2 Site Investigation

- .1 Examine the site and local conditions affecting the work and be satisfied that the work under this division can be satisfactorily carried out in accordance with the plans and specifications without changes.
- .2 No allowances will be made nor extra paid for unanticipated expense required to complete the work through failure to make this examination.

Part 3 Construction Schedule

- .1 The Contractor shall provide a detailed schedule for review and approval by the Departmental representative prior to mobilization.
- .2 Construction shall be staged such that not more than one greenhouse is out of service at any given time.
- .3 Each greenhouse has an allotted construction period of one week. Construction activities that do not interfere with greenhouse operations may take place outside of this one week allocation.
- .4 There shall be a minimum of one business day between completion of commissioning of one greenhouse and commencing construction in another, to allow for rotation of crops.

Part 4 Codes and Standards

- .1 Work shall be done in accordance with the regulations and requirements of CSA C22.1 including provincial amendments, Canadian Fire Underwriters' Association, the Inspection Authorities of Board or Department of Provincial, Municipal or Civic Authority or Utility company having jurisdiction and the latest issues of the National Building Code.
- .2 Work shall be done by qualified electrical tradesman with a Journeyman Electrician supervising or doing the work.
- .3 Abbreviations for electrical terms: to CSA Z85.
- .4 These drawings and specifications shall govern where they are more stringent than code requirements.

Part 5 Permits, Fees

- .1 Obtain and pay for all permits, licenses and certificates in force, required for the performance of the work.

- .2 Give required notices, and comply with local, provincial or federal laws, ordinances, rules, regulations, codes and orders relating to the work, which are or become in force during the performance of the work.
- .3 Submit to Electrical Inspection Department and Utility Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .4 Make reasonable changes and alterations required by the Inspection Authority without cost to the Owner.

Part 6 Drawings and Specifications

- .1 The drawings utilize standard symbols to indicate the general arrangement and location of fixtures, outlets, switches, panels, controls, etc.
- .2 The quantity and location of new supplemental light fixtures, sensors, instruments and control panels is indicative. The final arrangement is dependent on what a specific vendor requires to meet the performance specifications. The Contractor shall include any changes to accommodate the Vendor arrangement, without cost impact to the project.
- .3 The Departmental representative reserves the right to change the location of any piece of equipment without extra payment therefore, providing only that the change is requested before installation and that the new location is within 3 m of the original location.

Part 7 Shop Drawings, Product Data, and Samples

- .1 Submit shop drawings and samples in accordance with Section 01 33 00.
- .2 Each submittal shall include the following information, as applicable.
 - .1 Project No., name and location
 - .2 Equipment Tag Number
 - .3 Equipment manufacturer and model number.
 - .4 Manufacturer's name and description of item
 - .5 Equipment capacity, duty and performance across the full operating range of the equipment including but not limited to:
 - .1 Voltages and voltage regulation
 - .2 Currents / ampacity
 - .3 Number of phases / wires
 - .4 Frequency and frequency regulation
 - .5 Power factor
 - .6 Harmonic content
 - .7 Temperature rise, thermal capacity, insulation class
 - .8 Efficiency

- .9 Sound levels
 - .10 Agency approval and certification
 - .11 Single line, schematic, wiring and interconnection diagrams
 - .12 Functional block diagrams, logic diagrams, process flow charts
 - .13 HMI screenshots
 - .14 Bills of materials
 - .15 Details of construction materials, enclosure types, weights and dimensions, cable entry locations, position and size of components, busbars, foundations, drilling and mounting details
 - .16 Panel layouts, internal equipment layouts
 - .17 Catalogue cut sheets showing pertinent physical and operation characteristics of internal components.
 - .18 Lighting illuminance plan of each location in pdf format referencing actual building layout and equipment locations
 - .19 Reports
 - .20 Spare parts lists
 - .21 Warranty, service and support information
- .3 Manufacturer shall not commence fabrication or material shall not be delivered to the site until Departmental representative reviewed shop drawings and catalogue data is in the hands of the Contractor.
- .4 The above shop drawings are for inclusion in the Operating and Maintenance Manuals.
- Part 8 Operation and Maintenance Data**
- .1 Shall be submitted as per Division 1.
- Part 9 Record Drawings**
- .1 Record drawings shall be as per Division 1.
- .2 Updates shall include relocation of equipment, changes to size, type, rating and addition, deletion or modification of cabling system.
- Part 10 Unity of Manufacture**
- .1 Repetitive items in general classifications including fixtures, receptacles, cover plates, branch circuit panels, circuit breakers and control stations, etc., shall be of the same manufacture and type through the project.
- Part 11 Manufacturer's Instructions**
- .1 The Contractor shall be responsible for the correct installation and assembly of all items of equipment. Manufacturer's instructions shall be carefully read and rigidly adhered to in the installation.

- .2 Any damage resulting from failure to observe the manufacturer's instructions or as a result of proceeding with the work without complete knowledge of a particular component, will be the Contractor's responsibility. The contractor shall make good any loss or damage resulting from malpractice.

Part 12 Voltage Ratings

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

Part 13 Materials and Equipment

- .1 Provide materials and equipment in accordance with this Section.
- .2 Equipment and material to be CSA certified, and manufactured to standard quoted.
- .3 Factory assemble control panels and component assemblies.

Part 14 Finishes

- .1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1-1955.
 - .2 Paint indoor switchgear and distribution enclosures light grey to ANSI-61.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean, prime, and paint exposed hangers, racks, fastenings to prevent rusting.
- .4 Existing equipment shall be touched-up or repainted as required to make a finished project.
- .5 Name plates shall be kept free of paint.
- .6 Panel backboards shall have one coat of primer paint and two coats of ASA-61 gray enamel.

Part 15 Operating Environment

- .1 The equipment and wiring methods used shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - .1 Greenhouse
 - .1 Ambient Temperature: 0 °C to 40°C
 - .2 Altitude: 500 meters above sea level

- .3 Relative Humidity: 0 to 95%, condensing
- .4 Equipment within greenhouse areas shall be NEMA 3, 4 or 4X.
- .5 Wiring methods shall be suitable for wet locations. Conduit shall have corrosion resistant coatings per conduit specification section.
- .2 Crawlspace
 - .1 Ambient Temperature: 0 °C to 40°C
 - .2 Altitude: 500 meters above sea level
 - .3 Relative Humidity: 0 to 95%, non-condensing
 - .4 Equipment within crawlspace areas shall be NEMA 3, 4 or 4X.
 - .5 Wiring methods shall be suitable for wet locations.
- .3 Electrical Rooms
 - .1 Ambient Temperature: 10 °C to 30°C
 - .2 Altitude: 500 meters above sea level
 - .3 Relative Humidity: 0 to 95%, non-condensing
 - .4 Equipment within electrical rooms shall be NEMA 1.

Part 16 Equipment Identification

- .1 Identify electrical equipment with nameplates and labels as follows.
- .2 Nameplates:
 - .1 Laminated 3 mm thick plastic engraving sheet, black face, white core, mechanically attached unless specified otherwise.

Nameplate Sizes				
Size 1	10 x 50 mm	1 line	3 mm	high letters
Size 2	12 x 70 mm	1 line	5 mm	high letters
Size 3	12 x 70 mm	2 lines	3 mm	high letters
Size 4	20 x 90 mm	1 line	8 mm	high letters
Size 5	25 x 90 mm	2 lines	5 mm	high letters
Size 6	25 x 100 mm	1 line	12 mm	high letters
Size 7	25 x 100 mm	2 lines	6 mm	high letters

- .3 Nameplates as above, but showing white against red, shall be provided, as warning signs where rule 12-3036, and rule 36-006, Canadian Electrical Code applies.
- .4 Dymo or similar adhesive labels will not be accepted.
- .5 Wording on nameplates and labels to be approved by Departmental representative prior to manufacture, and where possible, be consistent with wording of existing labels in the facility.
- .6 Identification to be English.

- .7 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .8 Existing electrical equipment such as breakers, load centres, lighting panels, lighting contactor boxes, telephone cabinet, light control panel shall have nameplates installed.

Part 17 Manufacturer's and CSA Labels

- .1 Visible and legible after equipment is installed.

Part 18 Warning Signs

- .1 Provide warning signs, as specified and/or to meet requirements of Inspection Department and Departmental representative.
- .2 Use porcelain enamel signs, minimum 175 x 250 mm size.

Part 19 Field Quality Control

- .1 Complete installation checks, including those by manufacturers, in accordance with Division 1.
- .2 Complete startup and commissioning of equipment in accordance with Division 01.

Part 20 Cleaning

- .1 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt.
- .2 The interior and exterior of enclosures and boxes shall be cleaned of dust, dirt, and loose material, and if possible, shall be vacuum cleaned. All fastening screw holes provided in boxes and enclosures shall have a fastening screw installed.

END OF SECTION

Part 1 General

- .1 The requirements for selective demolition and removal of electrical components and incidentals required to complete work are described in this Section.

1.1 Definitions

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of light fixtures, conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3 Existing: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .4 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.2 Action and Informational Submittals

- .1 Action Submittals: Provide in accordance with Section 01 33 00– Submittal Procedures before starting work of this Section:
 - .1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 21–Waste Management and Disposal.
 - .2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.3 Administrative Requirements

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

1.4 Site Conditions

- .1 Existing Hazardous Substances: Departmental representative has performed a hazardous substances assessment and identified high pressure sodium and T5 fluorescent light fixtures requiring removal and disposal as follows:
 - .1 Hazardous substances will be removed by Contractor and disposed of in accordance with regulations in force as a part of Contract.

- .2 Immediately notify Departmental representative if materials suspected of containing hazardous substances are encountered and perform following activities:
 - .1 Refer to Section 01 41 00– Regulatory Requirements for directives associated with specific material types.
 - .2 Hazardous substances will be as defined in Hazardous Products Act.
 - .3 Stop work in area of suspected hazardous substances.
 - .4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.
 - .5 Proceed only after written instructions have been received from Departmental representative.

Part 2 Products

2.1 Repair Materials

- .1 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed.
- .2 Firestopping Repair Materials: Use firestopping materials compatible with existing firestopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

Salvage and Debris Materials

- .3 Material Ownership: Demolished materials become Contractor property and will be removed from Project site.

Part 3 Execution

3.0 Preparation

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
 - .1 Prevent debris from blocking drainage inlets.
 - .2 Protect electrical and mechanical systems that will remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with use of the building by Owner and users is minimized and as follows:
 - .1 Prevent debris from endangering safe access to and egress from occupied buildings.

- .2 Notify Departmental representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.1 Execution

- .1 Disconnect electrical circuits and panel feeders; maintain electrical service and main distribution panel as is, ready for subsequent Work.
- .2 Remove existing supplemental light fixtures, electrical devices and equipment including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
- .3 Perform demolition work in a neat and workmanlike manner:
 - .1 Remove tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
 - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.
- .4 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
- .5 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
- .6 Grind off conduits and make flush with surface of concrete where conduits are cast into concrete; seal open ends of conduit with silicone sealant and leave in place.
- .7 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

3.2 Closeout Activities

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre)
- .2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances in accordance with legal disposal site.

END OF SECTION

Part 1 General

1.1 Scope

- .1 This section covers work related to Section 26 05 00 for the provision of Wire and Cable.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01 33 00 and 26 05 00.

1.3 Delivery, Storage and Handling

- .1 Deliver Materials to the Jobsite in original factory packaging, labelled with manufacturer's name, address.
- .2 Divert unused metal Materials from landfill to metal recycling facility.
- .3 Disposal and recycling of existing wire as per local regulations.

1.4 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1.

Part 2 Products

2.1 Materials

- .1 Armored Power Cable (TECK90)
 - .1 CSA Teck90 armored power cable 1000 V.
 - .2 Copper conductors, quantity and size as indicated, bonding conductor
 - .3 1000 V XLPE Insulation
 - .4 Aluminum Interlocked armor
 - .5 PVC Jacket
 - .6 Thomas & Betts Star-Teck connectors or approved equal
- .2 Armored Control Cable (AIA)
 - .1 CSA Teck90 armored control cable 600 V
 - .2 Copper conductors, quantity and size as indicated, bonding conductor
 - .3 600 V XLPE Insulation
 - .4 Aluminum Interlocked armor

- .5 PVC Jacket
- .6 Thomas & Betts Star-Teck connectors or approved equal.
- .3 Non-armored Power Cable (RW90)
 - .1 Multi-conductor, CSA tray cable, non-armored for installation in conduit as indicated.
 - .2 Copper conductors, size as indicated,
 - .3 600 V, 1000 V XLPE Insulation, as indicated
- .4 Armored Instrumentation Cable (ACIC)
 - .1 CSA ACIC multiconductor armored instrumentation cable.
 - .2 Copper conductors, quantity and size as indicated
 - .3 600 V XLPE Insulation
 - .4 Overall PVC Jacket
 - .5 Individual and overall shields, twisted pair #16 AWG
 - .6 Individual and overall shields, twisted triad #16 AWG
 - .7 Interlocked aluminum armor
 - .8 PVC Jacket
 - .9 Thomas & Betts Star-Teck connectors or approved equal.
- .1 Non-Armored Instrumentation Cable (ACIC)
 - .1 CSA ACIC multiconductor armored instrumentation cable.
 - .2 Copper conductors, quantity and size as indicated
 - .3 600 V XLPE Insulation
 - .4 Overall PVC Jacket
 - .5 Individual and overall shields, twisted pair #16 AWG
 - .6 Individual and overall shields, twisted triad #16 AWG
- .2 Ethernet Cables (Cat 6)
 - .1 Cat 6 cable for Ethernet connections to equipment as indicated.
 - .2 4 twisted pairs, 23AWG solid strand conductors.

- .3 600V insulation for 600V MCC Ethernet connections. 300V insulation for other Ethernet connections.
- .4 Interlocked aluminum armor
- .5 PVC jacket.
- .6 Thomas & Betts Star-Teck connectors or approved equal.
- .3 Fiber Cable
 - .1 62.5 / 125 micron multi-mode fiber-optic cable
 - .2 Fiber count: 6
 - .3 Suitable for 1G application
 - .4 Tight buffer configuration, with inner jacket, interlocking armor and outer jacket
 - .5 Approved Product
 - .1 Belden FiberExpress
 - .6 Provide SC connectors as required to terminate 50% of the cable.

2.2 Wire Gauge

- .1 Where conductor sizes are not indicated on drawings, cable to be sized and installed or current carrying equal to or greater than the breaker or fuse protecting the cable. Size conductors for maximum 3% voltage drop.

Part 3 Execution

3.1 Installation

- .1 Install non-armored cables in conduit systems in accordance with Section 26 05 34.
- .2 Secure armored cables to strut supports on walls and ceilings.
- .3 Install lugs, stress relief tubes, tapes and any other materials required for correct installation and termination in accordance with manufacturer instructions. All termination kits and accessories shall be the proper equipment for the intended cable as indicated by the cable manufacturer.
- .4 Cable bends shall be not less than manufacturer and CEC requirements.
- .5 Connect shield of instrument cable to ground at one end only, preferably in the control panel. Do not ground instrument with shield wire, instead run a bonding conductor in the conduit.
- .6 Identify cables with engraved stainless steel cable tags, on both ends of cables, tags per cable schedules.

- .7 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
 - .1 Maintain phase sequence and colour coding throughout.
 - .2 Colour code: to latest CSA C22.1.
 - .3 Use colour coded wires in communication cables, matched throughout system.
 - .4 Uniquely identify each control wire, using typed, heat shrink wire markers at each end.
- .8 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

END OF SECTION

Part 1 General

1.1 Scope

- .1 This section covers work related to Section 26 05 00 for the provision of Splitters, Junction Boxes, Pull Boxes and Cabinets.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01 33 00 and 26 05 00.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1.

Part 2 Products

2.1 Splitters

- .1 Splitters shall not be used in this installation.

2.2 Junction and Pull Boxes

- .1 Boxes with Columbex Green Guard coating, or approved equal, for all conduits run within greenhouses.
- .2 Galvanized steel boxes for all other locations, to suit conduit type and size.

Part 3 Execution

3.1 Junction Boxes, Pull Boxes and Cabinets Installation

- .1 Install junction boxes and pull boxes in inconspicuous but accessible locations.

3.2 Identification

- .1 Install size 2 identification labels indicating voltage and phase in accordance with Section 26 05 00.

END OF SECTION

Part 1 General

1.1 Scope

- .1 This section covers work related to Section 26 05 00 for the provision of Outlet Boxes, Conduit Boxes and Fittings.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01 33 00 and 26 05 00.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1.

Part 2 Products

2.1 Outlet and Conduit Boxes General

- .1 Size boxes in accordance with CSA C22.1, Section 12.
- .2 102 mm square or large outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 Boxes with Columbex Green Guard coating, or approved equal, for all conduits run within greenhouses.
- .7 Galvanized steel boxes for all other locations, to suit conduit type and size.

2.2 Fittings - General

- .1 Connectors with nylon insulated throats.
- .2 Knock out filters to prevent entry of foreign materials.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.
- .5 Fittings with Columbex Green Guard coating, or approved equal, for all conduits run within greenhouses.

Part 3 Execution

3.1 Installation

.1 Outlet Box

.1 Provide boxes where indicated and as required for:

.1 Splices

.2 Taps

.3 Wire pulling

.4 Equipment

.5 Device location

.2 Install boxes surface mounted, except where an existing surface mount box is being replaced.

.3 Except where otherwise indicated, install boxes for vertical mounting of devices.

.4 Support boxes independent from conduit.

.2 Pull and Junction Box

.1 Locate as required by Canadian Electrical Code.

.2 Support boxes independent from conduit.

.3 Location of Wall Outlet Boxes

.1 Outlets are indicated on Drawings schematically. Consider locations indicated as approximate. Verify locations prior to rough-in.

.2 Confirm size and location of Equipment supplied and installed under other Sections, prior to rough-in.

.1 Do not install boxes back to back. Allow a minimum 150 mm separation.

.3 Position boxes in masonry walls to suit masonry course lines.

.4 Except where otherwise indicated, mount boxes at following heights:

.1 Local switches: 1400 mm.

.2 Receptacles:

a) General: 1400 mm.

- b) Above counters: 150 mm.
- .3 Telephone outlets:
 - a) Wall mounted telephone: 1400 mm.
- .5 Measure mounting height from finished floor to centre line of device.
- .6 The Departmental representative reserves the right to change location of outlets prior to installation with no change in Contract Price, provided that distance does not exceed 3 m from originally indicated location.

END OF SECTION

Part 1 General

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of Conduits, Conduit Fastenings and Conduit Fittings.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01 33 00 and 26 05 00.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1.

Part 2 Products

2.1 Conduits

- .1 Conduit size and material as indicated and according to CEC requirements. Minimum conduit size shall be 27mm.
 - .1 Rigid galvanized steel threaded conduit.
 - .2 Rigid steel conduit with Columbex Green Guard coating for all conduits run within greenhouses.

2.2 Conduit Fastenings

- .1 One hole steel straps to secure surface conduits 53 mm and smaller. Two holes steel straps for conduits larger than 53 mm.

2.3 Conduit Fittings

- .1 Fittings for raceways for CSA C22.2 No. 18.
- .2 Fittings and bends manufactured for use with conduit specified.
- .3 Conduit fittings with Columbex Green Guard coating, or approved equal, for all conduits run within greenhouses.

Part 3 Execution

3.1 Installation

- .1 Conduit installation methods and materials shall match existing, except as required to meet code requirements.
- .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

- .3 Conduits shall be surface mounted, unless otherwise indicated on the drawings or in this section.
- .4 Use liquid tight flexible non-metallic conduit for connection to instruments, motors, and HVAC equipment.
- .5 Install polypropylene fish cord in empty conduits.
- .6 Run ground wire in all conduits per CEC requirements.

3.2 Surface Conduits

- .1 Conduit is to be neatly installed parallel to building lines on channel supports.
- .2 Conduits shall have 1.5 m clearance (minimum) to infrared or gas fired heaters.
- .3 Group conduits wherever possible on surface channels.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Position conduits so that the markings on the conduit are facing the wall and are not visible.
- .6 Where cables, cable tray or conduits pass through floors and walls to hazardous areas and through fire rated walls, sealing shall be by approved fire sealants.

3.3 Conduits in Poured Concrete

- .1 Utilize existing sleeves in poured concrete for additional conduits, as required.

END OF SECTION

Part 1 General

1.1 Scope

- .1 This section covers work related to Section 26 05 00 for the provision and configuration of Networked Lighting Controls.
- .2 Control system shall include all hardware and software to accomplish the requirements specified herein.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01 33 00 and 26 05 00.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1.

Part 2 Products

2.1 System Objectives

- .1 The control system shall be compatible with, and offer user configurable control of greenhouse LED supplementary lighting fixtures and associated instrumentation supplied under this contract.
- .2 The control system shall have spare capacity for a minimum of 10% additional fixtures and instruments.
- .3 The control system shall allow operation in two modes:
 - .1 Automatic Mode
 - .1 The control system shall control the Daily Light Integral received at each plant canopy within the greenhouse compartments by way of wireless control of the output intensity of each individual fixture.
 - .2 The target DLI and the photoperiod shall be user adjustable set-points for each individual bench.
 - .3 DLI control units shall be Moles/m²/day. Set-point range shall be between 0 (OFF) and 50.
 - .4 The photoperiod shall be a user adjustable set-point for each individual bench. Set-point range shall be between 6 and 18 hours per day, with a user defined start time.
 - .5 The control system shall operate to control the DLI to the user set point, over the user set photoperiod, with a tolerance of $\pm 5\%$. Light fixture output will be off when outside of the photoperiod.

- .6 The PAR sensor(s) associated with each light fixture shall be monitored wirelessly by the control system, and used in the output intensity control of each fixture, to achieve a consistent DLI for the entire bench.
- .7 The spectrum composition shall be by user adjustable set-points, specific for each bench.
- .2 Manual Mode:
 - .1 The user may select intensity by operator set-point, displayed as a %, specific for each light fixture.
 - .2 The user may access white view mode by single button operation, specific for each bench.
 - .3 The spectrum composition shall be by user adjustable set-points, specific for each light fixture.

2.2 System Performance

- .1 The control system shall allow the light intensity output of each fixture to be individually adjustable in the range from 150 to 500 $\mu\text{mol/s/M}^2$ PAR (between 400 to 700 nm) at plant canopy, with the fixtures positioned at a distance of no less than 1000 mm above the plant canopy.
- .2 Light spectrum composition shall be fully adjustable:
 - .1 Across the PAR range of 400 nm to 700 nm
 - .2 To a specific wavelength
 - .3 To white color light viewing mode.

2.3 Configuration and Grouping

- .1 Control system shall allow wireless connection and addressing of individual LED light fixtures, PAR sensors and other instruments as required. Fixtures shall be tagged and identified in the control system as shown by drawings.
- .2 The control system shall be configured such that fixtures associated with each bench shall be arranged, named and viewed as a group.

2.4 Control Panels and Instruments

- .1 The control panels, associated components and instruments shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - .1 Ambient Temperature: 0 °C to 40°C
 - .2 Altitude: 500 meters above sea level

- .3 Relative Humidity: 0 to 95%, condensing
- .2 Control panel enclosures shall be NEMA 3, 4 or 4X, located within the greenhouse corridor, at a height not to cause obstruction to greenhouse operations.
- .3 Power Supplies
 - .1 Panels shall be powered from a single 120 V receptacle. Internal power supplies and batteries shall be provided to achieve required controller memory and ability to ride through power outages.
- .4 A single, dedicated internet service connection will be provided by the Owner. The Contractor is responsible for interconnections between control panels and controlled devices as required.
- .5 Quantity and location of control panels shown by drawings is indicative. Vendor shall be responsible for determining quantity and location of panels in order to achieve reliable communications with all devices supplied under this contract. The Contractor shall include any changes to accommodate the Vendor arrangement, without cost impact to the project.
- .6 Where multiple control panels are used, all control panels used in the system shall be identical in manufacturer, model, functionality and configuration.
- .7 One existing control panel, installed as part of the Lumigrow pilot testing, shall be de-commissioned and turned over to the owner. This contract shall be fulfilled by use of entirely new equipment.

2.5 Warranties

- .1 Control system panels, instruments and component warranty of a minimum of three years from time of substantial completion.
- .2 Minimum of three years technical support and updates for software, applications and similar for all equipment.

2.6 Web Based Application

- .1 The control system shall include a web based application available on mobile devices as well as desktop PCs for configuration and monitoring of the lighting system.
- .2 One or more control stations may be used, but shall utilize a single internet service, which is existing, and be combined in a single application. The application shall include adequate security and firewalls to protect the system.
- .3 The application shall include real-time display of each supplemental light fixture performance, as well as configuration and set-point data.
- .4 Account Types
 - .1 There shall be a minimum of three different account types: 'View Only', 'Configuration' and 'Admin'.

- .2 The application shall allow an unlimited number of user accounts of each account type. Each account shall have a unique user name and password to control access.
 - .3 In view-only mode, it shall not be possible to make changes to programmed set-points, with the exception that 'White View Mode' may be configured for periods of up to 15 minutes.
 - .4 Configuration mode shall allow viewing and adjustment of any parameter or set-point.
 - .5 Admin mode is intended to manage the access permissions of users and create and delete accounts as appropriate. The process of creating and configuring an account type must be achievable within five minutes.
- .5 The following failure modes are expected. Vendors may propose alternate failure mode responses for review during the tender period.
- .1 Upon failure of the internet connection to the control system, or a part of the system, all fixtures shall hold the last settings for spectrum and intensity to revert to 100% on, for all color channels.
 - .2 Upon failure of the power to the control system, the system will retain all settings such that normal operation can resume when power is restored. Duration of power failure of 48 hours should be considered. There is no standby power for the facility. An alarm to be generated on the 'Config' users screens and an email sent to the 'Admin' accounts.
 - .3 Communication failure with an individual fixture shall cause fixtures to hold the last settings for spectrum and intensity to revert to 100% on, for all color channels. An alarm to be generated on the 'Config' users screens and an email sent to the 'Admin' accounts.
- .6 Application Screens
- .1 The description of screen layout is a guideline. Alternate proposals may be made during the tender period.
 - .2 The application HMI screens shall be organized as one screen per greenhouse. The screen shall list each compartment with:
 - .1 Accumulated DLI for the day, and the target DLI, or when in manual mode, a letter 'M' to indicate manual and the intensity setting.
 - .2 Spectrum recipe
 - .3 Ambient reading for the greenhouse
 - .3 Clicking on any compartment shall bring up a detailed status and configuration page, with navigation back to the greenhouse overview page. Detailed status includes:

- .1 Output intensity of each fixture
- .2 PAR sensor reading
- .3 Photoperiod controls
- .4 Spectrum controls for each color
- .5 Accumulated DLI for the day, and the target DLI,
- .6 Trending graph showing PAR sensor readings for the photoperiod
- .7 Automatic / Manual mode controls
- .4 Provide additional status summary screen including:
 - .1 Overall accumulated operating kWh and cost per day, with configurable cost per kWh
 - .5 Alarm conditions are shown on the greenhouse overview pages.
 - .6 Color scheme of screens shall allow simple identification of fixtures or greenhouses in alarm condition and those in manual mode.

Part 3 Execution

3.1 Installation

- .1 Locate and install control panels as indicated.
- .2 Configure wireless communications, HMI screens and instruments

END OF SECTION

Part 1 General

1.1 Scope

- .1 This section covers work related to Section 26 05 00 for the provision of Wire and Cable.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01 33 00 and 26 05 00.
- .2 Submit a detailed lighting distribution plan for each bench type, showing min, max and average lighting levels, with zero ambient support, at heights above plant canopy in the range 1000 mm to 1500 mm. Indicate height(s) above plant canopy that meet the project requirements.

1.3 Delivery, Storage and Handling

- .1 Deliver Materials to the Jobsite in original factory packaging, labelled with manufacturer's name, address.
- .2 Divert unused metal Materials from landfill to metal recycling facility.
- .3 Disposal and recycling of existing lamps as per local regulations.

1.4 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1.

Part 2 Products

2.1 Fixture Performance

- .1 Optical Performance
 - .1 Readily adjustable light fixtures (spectrum, intensity, and photoperiod), in conjunction with the lighting control system.
 - .2 Light intensity adjustable in the range from 150 to 500 $\mu\text{mol/s/M}^2$ PAR (between 400 to 700 nm) at plant canopy, with the fixtures positioned at a distance of no less than 1000 mm above the plant canopy.
 - .3 Light spectrum composition shall be fully adjustable:
 - .1 Across the PAR range of 400 nm to 700 nm
 - .2 To a specific wavelength
 - .3 To white color light viewing mode.
- .2 Electrical Characteristics
 - .1 Nominal Operating Voltage: 120 V AC, tolerances per ANSI C84.1 range A for utilization voltage.

- .2 Nominal Operating Frequency: 60 Hz, $\pm 10\%$
- .3 Power factor: > 0.85
- .4 Complete with 120 V NEMA 5-15P plug and 10' flexible cord.
- .5 Coefficient of utilization (CU) to be a minimum of $1.9 \mu\text{mol/J (PPF/W)}$
- .3 Controls Characteristics
 - .1 Built-in wireless controls, compatible with control system per Section 26 09 43
- .4 Mechanical Characteristics
 - .1 The fixtures and associated instruments shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - .1 Ambient Temperature: 0°C to 40°C
 - .2 Altitude: 500 meters above sea level
 - .3 Relative Humidity: 0 to 95%, non-condensing
 - .2 Suitable for mounting on hangar frame, with strut support locations as indicated. Configuration shall not require modification to strut locations.
 - .3 Fixtures shall be IP 24 rated, minimum
- .5 Certifications
 - .1 RoHS compliance, mercury and lead-free
 - .2 cUL or CSA certified
 - .3 Fixtures that require field certification will not be permitted
- .6 Warranties
 - .1 Fixture and instrument warranty of a minimum of three years from time of substantial completion.
 - .2 Light intensity depreciation according to IESNA (50,000 hours at L70) at 40 dg C
 - .3 Minimum of three years technical support and updates for software, applications and similar for all equipment.

2.2 Canopy Performance

- .1 Fixtures shall be configured to achieve a Daily Light Integral of $30 \text{ Moles/m}^2/\text{day}$ at plant canopy, across the entire area of each bench, over a nominal 16 hour photoperiod. DLI is a combination of natural ambient light and the LED supplemental light fixtures.
- .2 Homogeneity minimum to average of 0.8 – 1.0 of light intensity, at any intensity selected, at the manufacturer recommended height above plant canopy.
- .3 Power required shall not exceed 1200 W, or 10 A per phase, for a total of 3600 W, 10 A per bench, maximum. One panelboard circuit per bench.

- .4 Heat rejection per canopy shall not exceed 15,000 BTU / hr
- .5 Fixture weight per bench shall not exceed 80 kg.

2.3 System Performance

- .1 Electrical Loading:
 - .1 Overall loading of the complete lighting system shall not exceed 365 kW, or 1012 A.
 - .2 Loading shall be balanced between phases as far as practical.
 - .3 Loading on panel GNL1A shall not exceed 81 kW, or 225 A
 - .4 Loading on panel GNL1B shall not exceed 63 kW, or 175 A
 - .5 Loading on panel GNL2B shall not exceed 18 kW, or 50 A
 - .6 Loading on panel GNL1C shall not exceed 81 kW, or 225 A
 - .7 Loading on panel GNL1D shall not exceed 86 kW, or 240 A
 - .8 Loading on panel GNL1E shall not exceed 36 kW, or 100 A
- .2 Operating power factor with all fixtures in operation at 100% power output shall be between 0.85 and 0.95 lagging.
- .3 Operating harmonics of the system shall be less than 5%, with all fixtures in operation at 100% power output, with the following reference points of common coupling:
 - .1 Line side of panel GNP1-120/208V-1200A, which serves greenhouses A, B and C
 - .2 Line side of panel GNP2-120/208V-1200A, which serves greenhouses D and E
 - .3 Notify the Departmental representative not less than 7 days before the close of bids if harmonic mitigation equipment is required on the power system to achieve the indicated harmonic performance.

2.4 Optical Control Devices

- .1 Provide a minimum of one (1) new PAR sensor for each supplemental light fixture, to send information to the supplemental growth light control system; PAR sensors shall be located to most closely reflect lighting levels at plant canopy, taking into account ambient light.

2.5 Design Basis

- .1 Pilot testing has been carried out using LumiGrow Pro650e fixtures. However, use of these fixtures in pilot testing is not intended to grant approval, otherwise supersede performance requirements, or restrict the tendering process.
- .2 The manufacturer, model, quantity and arrangement of fixtures shown may be modified from those shown by drawings, and is open for proposal by Vendors, providing the optical, electrical and mechanical performance requirements can be met.
- .3 The Contractor is responsible for ensuring that proposed systems will meet the performance requirements set out by the contract documents. The Contractor shall include any changes to accommodate the Vendor arrangement, without cost impact to the project.

- .4 Six existing LED supplemental light fixtures, installed as part of the Lumigrow pilot testing, shall be de-commissioned and turned over to the owner. This contract shall be fulfilled by use of entirely new equipment.

2.6 Spares

- .1 Provide spare fixtures, complete with required control devices, not less than 2% of the total quantity installed for the project.

Part 3 Execution

3.1 Storage

- .1 Storage of fixtures and associated equipment is the responsibility of the Contractor. Fixtures shall be stored on-site in a secure storage location per 01 52 00 and in accordance with manufacturer recommendations.

3.2 Installation

- .1 Locate and install luminaires as required by Vendor to meet the performance requirements.

3.3 Wiring

- .1 Connect luminaires to lighting circuits as indicated
- .2 Coil and support flexible power supply cable, while allowing adjustment of height above plant canopy.

3.4 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION