Part 1 General

1.1 RELETED SECTIONS

.1 Division 03 - Concrete

.2 Division 07 – Thermal and Moisture Protection

.3 Division 08 – Openings

.4 Division 09 – Finishes

.5 Section 13 35 13 - Greenhouse Control

.6 Division 15 - Mechanical

.7 Division 23 - Heating, Ventilating and Air Conditioning (HVAC)

.8 Division 26 - Electrical

.9 Division 31 – Earthwork

.10 Division 32 – Exterior Improvements

.11 Division 33 – Utilities

1.2 SUBMITTALS

.1 Submit required submittals in accordance with section 01 33 00 – Submittal Procedures.

.2 Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each product and system used. Provide manufacturers' certifications stating that products and systems comply with requirements. List and describe features of control systems, performance and operating characteristics

.3 As-Built Drawings: Revise shop drawings and resubmit as-built drawings in accordance with section 01 78 00 – Closeout Submittals, making use of field set marked up by site foreman. Collect and add as-built drawings from all suppliers.

.4 Manuals: Provide Operation and Maintenance Manuals in accordance with section 01 78 00 - Closeout Submittals, listing operating and maintenance instructions, emergency instructions, safety considerations, parts listings, exploded views, parts sources and circuit diagrams. Include list of all operating components and details.

.5 Prior to the erection of the greenhouses, the greenhouse supplier must provide anchorage drawings for the greenhouses signed and sealed by a Professional Engineer licensed in the Province of Prince Edward Island.

1.3 SHOP DRAWINGS

.1 Shop Drawings: Submit coordinated shop drawings for the fabrication and installation of the greenhouse, sealed by a Professional Engineer licensed in the Province of Prince Edward Island, including; plans, elevations, sections, detail sections of framing members and glazing system, hardware, mounting heights, anchorage and glazing details, placement of all components supplied under this Section. Show and provide coordinated

details of support members or other support provisions for lighting, ventilators, shading, irrigation, benches, VAF fans and heating systems, as well as all other overhead equipment. No mock-ups are required, but installation must match with the existing greenhouse, except as noted in these drawings and specifications. Follow procedures and requirements as per section 01 33 00 – Submittal Procedures.

1.4 SAMPLES

.1 Provide samples of finish on structural members, glazing system members, doors and flashing. Provide samples of finish on foam sandwich panel in lower sections of walls and partitions. Provide samples of shade cloth, insect screening and screen framing. Minimum size of samples, 300mm long or 300mm by 300mm, as appropriate. Follow procedures and requirements as per section 01 33 00 - Submittal Procedures.

1.5 REFERENCES

.1 Standards: Comply with the National Building Code of Canada 2010 (NBC) and referenced applicable standards.

.2 National Farm Building Code of Canada 1995

.3 CAN3-S157-M83 – (R2003) - Strength design in aluminum.

.4 CAN/CGSB-12.20-M89 – Structural Design of Glass for Buildings.

.5 CAN/CGSB-12.1-M90 – Tempered or Laminated Safety Glass.

.6 CAN/CSA-S16.1-09 (R2010) - Design of Steel Structures.

.7 G164-M81 – Hot dip galvanized steel.

.8 A123-89A - Coatings on Iron and Steel Products.

.9 G40.20-04/G40.21-04 (R2009) - General requirements for rolled or welded structural quality steel/ Structural quality steel.

.10 ASTM A1011 / A1011M - 10 - Hot-Rolled Carbon Steel Sheet and Trip, Structural Quality.

.11 CSA W 47.1 – 09 (2012) - Mechanical Properties, General – Certification of Companies for Fusion Welding of Steel Structures..

.12 CSA W 59-09 (R2008) - Welded Steel Construction (Metal-Arc Welding).

.13 ASTM C1048-12 - Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.

.14 CAN/CGSB-12.8-97 - Insulating Glass Units.

.15 ASTM C1048-12 – Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.

.16 ASTM E331-00 (2009) - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

.17 ASTM E283-04 (2012) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.18 ASTM E331-00 (2009) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

.19 AAMA 103-07 details process for certification of windows and doors for air-water-structural and thermal product certification.

1.6 DESIGN CRITERIA

.1 Submit structural calculations for greenhouses signed and sealed by a Professional Engineer licensed in the Province of Prince Edward Island, along with signed and sealed shop drawings. Demonstrate structural performance of all components of the greenhouse structure and cladding and compliance of all materials, components and structural systems with the NBC 2010 rests with the greenhouse manufacturer.

.2 Structural Performance: Design aluminum structure to CAN3-S157-M83 (R2003), aluminum glazing support system to CAN3-S157-M83 (R2003), glazing to CAN/CGSB-12.20-M89, CAN/CGSB-12.1-M90, steel supports to CAN/CSA-S16.1-94 (R2010) and galvanizing to G164-M81 and A123-89A.

.3 Deflections: Submit live load deflection calculations for the structure as a whole and for individual components, including purlins, girts, gutters, glazing bars. Do not exceed deflection limits of applicable codes nor those imposed by serviceability considerations. In general, do not exceed L/120 unless serviceability considerations impose more severe deflection limits.

.4 Design Loads: Calculate design loads in accordance with the NBC 2010. Use Part 4 loads and importance factors for normal occupancy. Allow for sliding and drifting snow, per the NBC 2010 Structural Commentaries (Part 4 of Division B). Calculate Wind Loads and Effects per the NBC 2010 Structural Commentaries (Part 4 of Division B, using an exposure factor, Ce = 0.7. Allow for overhead mechanical and electrical equipment (minimum 0.29kPa UDL in the greenhouse compartments and minimum 0.7kPa UDL in greenhouse corridors), overhead support of plant material (minimum 0.2kPa UDL in the greenhouse compartments) in addition to dead and live loads as calculated (these loads to be considered together with gravity loads but not with wind uplift). In addition to the above, roof bars to be sized to carry a 500N concentrated load at the center of the span.

.5 Load Combinations: Per NBC 2010, Part 4

.6 Lateral Bracing: Structure shall include adequate bracing for the lateral support of structural members and framing, and for stability of the structure for resistance to wind forces and seismic loads. Locations of lateral bracing are shown on the drawings and must be respected.

.7 Thermal expansion: Structure shall include adequate provision for thermal movement. Expansion joints to be installed as per drawings and as required to accommodate thermal movement.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Protect materials during delivery, storage and handling to comply with manufacturers' directions and as required to prevent damage and deterioration. Store all greenhouse

components, including but not limited to, glass and aluminum indoors, away from rain, snow and condensing conditions.

Part 2 Products

2.1 ALUMINUM

.1 Framing Extrusions, including frames, ties, purlins, girts, posts, beams, gutters and rigid frames: Alloy 6061 T6 or 6063 T5.

.2 Glazing System, including bar base, bar cap, ridge, vent top and bottom rail, gutter adapter, sill, end bar: Alloy 6061 T6 or T5 or Alloy 6063-T54.

.3 Sheet: Alloy 3003-H14.

.4 Plate: Alloy 6061 T6 or T5 Bar Stock or Alloy 6063 T54 Bar Stock.

.5 Anodizing: Clear anodizing 0.1 mm (0.0004") on doors, flashing sheet and plate.

2.2 STRUCTURAL STEEL

.1 Structural steel design, fabrication and erection to CAN3-S16.1-01.

.2 Structural steel to CAN/CSA-G40.20 and .21-F04 (C2009), Grade 350W.

.3 HSS gutter posts and gable columns, as shown on drawings.

.4 Roof truss top and bottom chords and lacing to be HSS, Class 2H.

.5 Sway bracing, HDG or stainless steel solid rod, as shown on drawings.

.6 All structural steel HSS members: 50 ksi. Hot dip galvanized.

.7 Sheet steel: pre galvanized roll formed gutters to ASTM A1011/A1011M-12b

.8 Baseplates, stiffeners, wrap-arounds and lugs to ASTM A1011/A1011M-12b.

.9 Connections: bolted connections - friction type to CAN/CSA-S16.1-09 (R2010).

.10 Welded connections - all connections, unless otherwise noted, welded, to develop full wall strength of HSS structural member, using fillet welds to CSA W 47.1-09 (2012) and CSA W 59-09 (R2008).

.11 Maintain on file, certified copies of mill reports covering chemical and physical properties of steel used in this work.

2.3 FASTENERS

.1 Structural fasteners: A325 Hot Dip Galvanized or 300 Series Stainless Steel

.2 Exterior glazing system fasteners: 300 Series Stainless Steel.

.3 Concealed fasteners: Hot Dip Galvanized.

.4 All other fasteners: 300 Series Stainless Steel.

.5 Anchor bolts:
- .1 This division to supply and install all anchor bolts to attach greenhouse structure to concrete curbs and steel brackets provided.
- .2 Anchor bolts to be epoxy adhesive system proportioned to meet the calculated and required loading conditions.
- .3 Adhesive anchors shall consist of a threaded anchor rod, nut, and washer, and an injectable adhesive material.
- .4 Anchor rods to be furnished with chamfered ends so that either end will accept a nut and washer.
- .5 Manufactured to meet the following requirements:
  - .1 ISO 898 Class 5.8.
  - .2 AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593-02 (2008) (condition CW).

2.4 Cladding System

.1 Roof glass for all compartments: Fully tempered single float glass, 4mm minimum thickness, or thicker, as required to meet loading conditions.
- .1 Fully tempered clear float glass to comply with ASTM C1048-12, Kind FT, Condition A, Type I, Class 1, Quality q6. Tempered glass to CAN/CGSB-12.1-M90, "Glass, Safety, Tempered or Laminated".
- .2 Adjust glass thickness and/or purlin spacing to suit, considering wind loads and dead loads as calculated and limiting deflections to L/200 or the flexure limit of the glass, with full recovery of glazing materials, whichever is less.. Tempered glass to CAN/CGSB-12.1-M90, "Glass, Safety, Tempered or Laminated". Laminating film: SentryGlass UV.

.2 Sidewall and gable end glass for all greenhouse compartments: Fully tempered double insulated glass units, 4 mm minimum thickness (both lites), or as required to meet loading conditions.
- .1 Fully tempered clear float glass to comply with ASTM C1048, Kind FT, Condition A, Type 1, Class 1, Quality q6, 25 mm overall thickness, 4mm on 4mm, or thicker, as required to meet loading conditions. Units to CAN/CGSB-12.8-M97, "Insulating Glass Units"
- .2 Interior sidewall, partition wall and door glass: Fully tempered single float glass, 4mm minimum thickness, or thicker, as required to meet loading conditions. Fully tempered clear float glass to comply with ASTM C1048-12, Kind FT, Condition A, Type I, Class 1, Quality q6. Tempered glass to CAN/CGSB-12.1-M90, "Glass, Safety, Tempered or Laminated".
- .3 Insulated foam sandwich panel at exterior building corners and at gutter downspout penetrations and elsewhere, as shown on the drawings: Anodized aluminum finish on 2 mm aluminum skin, laminated on polystyrene foam, type 2, 51mm minimum in thickness.
- .4 Outer glass seal: gunned butyl and shimmed butyl tape wet seal or UV stable EPDM or neoprene gasket.
- .5 Inner glass seal: UV stable EPDM or neoprene gasket.
- .6 Gutter downspout: provide and install aluminum gutter downspouts from the gutter elevation to the exterior.
  - .1 Gutter downspouts to penetrate the base wall where shown on the drawings.
  - .2 All horizontal gutter downspouts and associated piping to be insulated, with aluminum jacket.
  - .3 Vertical downspout runs to be bare aluminum.
  - .4 Inlet to gutter downspout to have stainless steel wire type roof strainers.

.7 Condensation system: Provide system of integral gutters in roof bars, purlin bars, vent bottom rails and gutter adapters, effective at collecting condensate from the glass and weeping to under-gutter drip channels.
  .1 Provide drip collectors under gutters effective at collecting condensate from the gutters and weeping to exterior.

.8 Partition cladding system to be installed in the plane of the centreline of the partition columns and between the columns.
  .1 Columns and frames to be accessible from either side of the partition to allow for attachment of supports for heating, lighting and other overhead equipment.

2.5 FLASHING AND SEALING

.1 Exterior and interior curbtop flashing: 1.6mm minimum thickness anodized aluminum sheet, preformed, covering junction between glazed walls and concrete curbs.

.2 Connection at junction of greenhouse to existing greenhouses: Rubber expansion joint flashing system, aluminum and rubber preformed units with factory made junctions and 1.6mm minimum thickness anodized aluminum sheet, preformed cover flashing, where shown on drawings.

.3 Expansion joint(s): Rubber expansion joint flashing system, aluminum and neoprene rubber preformed units, as shown on drawings with factory made junctions and 1.6mm anodized aluminum sheet, preformed cover flashing.

.4 Glazing System Sealants: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C920-11 requirements, including those referenced for Type, Grade, Class, and Uses.
  .1 One part polyurethane sealant: Type S, Grade NS, Class 25, Uses NT, G, A, and, as applicable to joint substrates indicated O.
  .2 Preformed Butyl-Polyisobutylene Glazing Tape: Provide manufacturer's standard solvent-free butyl-polyisobutylene formulation with solids content of 100%; complying with AAMA 800-10; in extruded tape form; non-staining and non- migrating in contact with porous surfaces; packaged in rolls with a release paper on one side; with continuous integral rubber shim spacers.
  .3 Flashing and building junction Sealants: silicones sealants to be applied strictly in accordance with manufacturers' recommendations, to be used where noted and where required to control water and air infiltration.

.5 Sealant and Flashing Performance standards: ASTM E283-04 air infiltration and ASTM E331-00 (2009) water infiltration.
  .1 Glazing system shall be tested and certified to meet these standards.
  .2 Tests shall be conducted in accordance with test criteria set forth in AAMA 103-07 for static air infiltration and static water resistance.

.6 Entire enclosure shall have an infiltration rate not exceeding 1.0 air change per hour, with an exterior wind velocity of 25 km/h and an indoor to outdoor air temperature differential of 20° C.

.7 Terminations and Junctions: Provide closure members at ridges, corners, eaves, sills and gutters, designed to connect with adjacent members and to provide weatherproof terminations and junctures.
  .1 Corner junctions shall be mitered and rounded where possible.
  .2 Partitions shall be fully sealed to minimize air exchange between compartments and to the corridor.

.8 Flashing details at top of partition walls, at top of concrete curbs and at access panel locations to be fully sealed and caulked, with no openings, gaps, cracks or holes.

.9 Base wall flashing to be installed at top of concrete curbs with a continuous caulking joint between the top of the concrete curb and the bottom of the flashing.
.1 Water test to be performed to confirm water tight condition of base wall.

.10 Provide waterproof insulation material at eave-gutter connection, from the inner face of the connection, on exterior walls. Insulation value must be a minimum of 2.5 W/m2-C.

2.6 VENTILATORS

.1 Ridge Ventilators: Provide independent continuous ridge sash vents on both sides of each ridge of each compartment and independently on both sides of each ridge and in each section of the corridors.
.1 Ridge vents to be 1200 mm wide in the compartments and 914 mm wide in the corridor sections, with a weather tight hinge, and weather tight fit at the vent header and vent ends.
.2 Rack and Pinion vent openers: Rack and Pinion vent openers: steel U profile rack with alloy pinion gear, for 25.4mm pipe shaft, installed on 1200 approx, on center, as shown on drawings.
.3 Drive shaft: 25.4 mm hot dip galvanized pipe.
.4 Shaft bearings: 33.4 mm pillow block bearings, suitable for the drive shaft, with high temperature seals, installed on 2400 mm approx. on center, at column locations.
.5 Drive motor: 208V-3 Phase gear motor, maximum 5 RPM, self locking double worm gear, complete with built in limit switches and built in 1000 ohm potentiometer.
.6 Supply complete with side mounting plate and chain couplings to bolt to 25mm galvanized pipe drive shaft.

2.7 INSECT SCREENS

.1 Insect screens in ridge vents: provide accordion type insect screen material which automatically deploys on vent opening and retracts on vent closing.
.1 Screen materials: suitable for exclusion of thrips and to be UV resistant.
.2 Provide and install effective retention devices to ensure screens stay in vent aperture without pinching or jamming.
.3 Provide and install effective seals at the entire perimeter of each accordion screen, ensuring that any cracks or gaps are no larger than the screen mesh opening size.

2.8 DOORS AND FRAMES

.1 Provide and install doors, frames and hardware for doors located in glazed walls.
.1 Interior compartment and corridor doors to be 1070 mm x 2134 mm single leaf or double leaf as shown on drawings.
.2 Interior doors to be medium stile, anodized aluminum, with 6mm anodized aluminum kick panels and 5mm tempered glass upper panels, welded corners.
.3 Exterior door to be medium stile, anodized aluminum, thermally broken frame and door leaf, with 25mm anodized insulated kick panel and 25mm tempered insulated glass upper panels, welded corners.
.4 Frames, 44.5 mm x 100 mm with 2mm with muntin bar.

.2 Refer to Section 08 71 00 for Door Hardware.

2.9 SHADE SYSTEMS

.1 Each of the greenhouse compartments shall be provided with a slope-flat-slope shading system in the roof area, suspended from stainless steel guide wires.
  .1 Horizontal shade cloth to be knitted reflective and porous cloth, fire retardant, 60% shade value and 55% of energy saving. UV stable in outdoor applications.

.2 Each of the greenhouse compartments, as shown on drawings, will also have south end wall shading systems (all compartments will have 1 vertical shade, installed from sill height to the gutter height.
  .1 The cloth shall be suitable for roll-up application and shall be driven by greenhouse grade waterproof tube motors, 50mm in diameter. The roll up tube to be weighted to provide positive cloth travel with the expected air movement in compartment due to wind and the evaporative cooler upward air flow. South and North facing gable end walls in compartments also to have side wall shading, as described above.
    .1 Vertical shade cloth to be knitted reflective and porous cloth for roll-up applications, fire retardant, 60% shade value and 55% of energy saving. UV stable in outdoor applications.

.3 Drive motor in roof areas: 208V-3 Phase gear motor, maximum 5 RPM, self locking double worm gear, complete with built in limit switches and built in 1000 ohm potentiometer. Supply complete with side mounting plate and chain couplings to bolt to 25mm galvanized pipe drive shaft.

.4 Drive motor for side curtains: tube motor, for use with 50 mm aluminum pipe, 120V-1 Phase, complete with built in limit switches. Tube motor to be water proof suitable for outdoor application. Supply complete with installation hardware and intermediate hanger supports at 2400 mm on center.

.5 Drive tube: 50mm outside diameter Aluminum shaft.

.6 Drive cables: 3mm 7x19 stainless steel aircraft cable

.7 Return pulleys: 75mm of diameter with ball bearings, supplied complete with mounting bracket

.8 Support Wires: 2mm stainless steel wire

.9 Leading edge tube: 19mm of diameter galvanized steel tube

.10 Cloth shall be hemmed

.11 Roof shade cloth shall be hemmed and supplied with hooks installed on 300mm on center. Support wires shall be spaced at 1200mm maximum on center.

2.10 BENCHES

.1 Provide benches as per drawings. Benches to have 4 legs, 8 adjustable feet, be 660 mm in height to the bench mesh top and to be adequately braced for stability with a full crop load. Legs to be spaced to meet loading and deflection criteria and not more than 2100mm apart.
  .1 Materials: Legs, frame and bench mesh to be of hot dip galvanized steel or aluminum. Edge rail to be of aluminum.
  .2 Tops: Aluminum or hot dip galvanized expanded metal; : ¾ 10-13, with cross supports sufficient to provide a load capacity of 1.9 kPa with no more than 3mm deflection. Maximum span between cross supports: 500mm. Expanded metal to be supplied in one piece across the top. Junction must occur at a cross support.

.3 Edge rail: 90mm minimum in overall height above bench top, to accept ebb and flow tray liners, of extruded aluminum. Junction of edge rails to be rounded.
.4 Legs of tubular round or square HDG steel or aluminum, recessed a minimum of 50mm from the bench edge.
.5 Legs to be continuously adjustable to allow for 75mm total variation in finish floor elevation, using a screw adjustment device
.6 100mm by 50mm base plates are to be provided.
.7 Roll top benches to have effective anti-tip brackets, 1 ½" anodized aluminum roll tubes with two collars engaging a leg cross bar at each end of each tube to avoid migration of the tube. Roll tubes to be cut short at the cross aisle end(s) to avoid a pinch hazard.
.8 Bracing to be installed to maintain stability and bench location.
.9 Fasten bench legs to floor using stainless steel anchor bolts. Benches to be removable. Anchor bolt socket to be filled with stainless pan head bolts when benches are removed.
.10 Benches shall be leveled to an accuracy of +/- 3mm over the full length and width of the bench. A water level shall be used to check this.

2.11 HORIZONTAL AIR FLOW FANS

.1 Provide HAF fans in greenhouse compartments, mounted off the truss bottom chord, as shown on the drawings.
.1 Fans in large compartments: 610 mm diameter, aluminum blades and hot dip galvanized baskets, galvanized steel brackets and galvanized or stainless steel hardware, 375W motor, 120VAC.
.2 Fans in medium compartments: 508 mm diameter, aluminum blades and hot dip galvanized baskets, galvanized steel brackets and galvanized or stainless steel hardware, 250W motor, 120VAC.
.3 Mounting Bracket: Provide appropriate mounting bracket and structural support within greenhouse.

2.12 EVAPORATIVE COOLERS

.1 Stainless steel grade 304 construction.

.2 Upward discharge model.

.3 300mm. thick cellulose pad at each end of unit, total pad area 1.5m^2.

.4 Blower motor: 208VAC, 3 phase, 1.13kW, 2 speed, 2360 L/s, 1750/825 RPM.

.5 Cooler low and high speeds and cooler pump to be independently controlled (3 outputs).

.6 Centrifugal fan to deliver rated output (2360 L/s) at 62 Pa external static pressure.

.7 Centrifugal fan to be of baked enamel steel construction.

.8 Fan shaft to be made of solid stainless steel grade 304 complete with keyway and set screws for securing pulley, no hollow tube shaft allowed.

.9 Fan bearings to be of stainless steel and to have externally mounted remote grease nipples.

.10 Cooler side and top panels to be removable for access to both sides of fan, water pump, float switches, supply solenoid valve, purge solenoid valve, low level switch and high level switch.

.11 Cooler to have purge cycle function, initiated by the computer control system.

.12 Coolers to have legs or skid channels to permit handling with fork lift.

.13 Coolers to have lifting eyes.

.14 Coolers to have channel frame construction with lifting lugs.

.15 Fan shall be isolated by springs mounted to the unit frame.

.16 Discharge collar on the interior of the unit must be provided.

.17 Coolers to be air tight against the full static pressure of the fan, both suction and discharge sides.

.18 Water line to cooler units: 12mm copper. Provide water shutoff valve.

.19 Water pump in cooler unit serves both pad sections and drains to both sump sections. Sump sections to be interconnected.

.20 Drain line for purge pump: Schedule 80 PVC. 25mm drain connection and 25mm overflow connection to each cooler.

.21 All factory-mounted electrical enclosures to be weather proof (NEMA 3R) or to have equivalent weather protection. Complete with 8 pole disconnect in weather proof box. Cooler to be have electrical safety certification for use in Canada.

2.13 LIGHTING SUPPORTS

.1 Lighting support tracks of Hot Dip Galvanized Steel channel or HSS: as shown on drawings; spanning from truss to truss, carry the lighting fixtures. Connect the tracks to the bottom chord of the roof trusses.

- .1 Size steel channel or HSS tracks to carry a maximum of 8 supplemental lighting fixtures on each run, in addition to other mechanical and electrical equipment shown. Minimum suspended load is 0.29 kPa uniformly distributed over the entire compartment.
- .2 All hangers, bracket, cables and fasteners for the supports shall be aluminum or stainless steel.
- .3 Install hangers with seismic restraint fasteners

2.14 SUPPLEMENTAL LIGHTING FIXTURES

.1 Provide lighting support tracks for all fixtures shown on drawings, 400 W HPS lighting fixtures and hang the fixtures where directed.

- .1 Division 26 to provide twist lock electrical outlets and infrastructure for 600 W HPS fixtures and lamps, as indicated on the drawings.

.2 Fixture: horticultural lighting fixtures, horizontal mount, coated aluminum reflector, aluminum ballast housing, weather proof junction box, 400 W HPS, 347V.

- .1 Core Coil Design Ballast types: CWI/CWA
- .2 Features:
  - .1 Louvered side ventilation
  - .2 Durable extruded aluminum body
  - .3 Damp location rated
  - .4 Internal heat shield protects components

.5 Cast aluminum mounting system
.6 Multi tap rated
.7 North American Ballast
.8 CSA and CUL approved
.9 Lamp: 600W HPS, horizontal mount enhanced spectrum for horticultural lighting.

2.15 ANODIZED ALUMINUM INFILL PANELS

.1 Provide anodized aluminum infill panels, 6mm thick, where indicated on the drawings and where required to accommodate pipe, duct and electrical penetrations through the glazed partition walls.

.2 Coordinate the location of the panels and the work with Electrical and Mechanical install to facilitate connections and minimize the size and number of panels.

.3 Division 22 and 23 to install pipes, ducts and other mechanical work, except as noted in this specification section.

.4 Division 26 to install electrical conduit, wiring and electrical devices.

.5 Receive site instructions and coordinate work with Division 22, 23 and 26 contractors to facilitate installation of their work in the greenhouse areas and to facilitate connections and minimize the size and number of panels.

.6 All pipe penetrations must have appropriate sealing. Follow prescriptions of sections 22 05 17, 22 05 18, 23 05 17, 23 05 18 and 26 05 44.

2.16 OVERHEAD EQUIPMENT SUPPORTS

.1 Provide and install hot dip galvanized steel supports for overhead gutter heating pipes in the greenhouse compartments and greenhouse corridors, for mid-wall mounted heating pipes in compartments and for other overhead equipment included in this Section.

.2 Support to be made of 51 mm x 51 mm x 6.4mm steel angle (or stronger when required), as shown on the drawings, and to be located on the whole perimeter of each greenhouse compartment.

Part 3 Execution

3.1 PREPARATION

.1 Examine areas and conditions where greenhouse is to be installed. Notify general contractor in writing of conditions detrimental to proper and timely installation of work.

.2 Coordinate and furnish anchorages, setting diagrams, templates and directions for installation of anchorages. Coordinate delivery of these items to the site.

.3 Dissimilar metals: where aluminum surfaces come in contact with ferrous metals, concrete or other incompatible materials, keep aluminum surfaces from direct contact using required galvanic barriers.

3.2 ERECTION

.1 Erect greenhouses and related components in accordance with manufacturers' written instructions and final reviewed shop drawings and erection drawings.

.2 Set, level and anchor sills and base plates. Grout under column base plates, set aluminum framing in proper location, alignment, level, true and free of rack, measured from established lines and levels. Provide temporary bracing and supports as required to ensure stability during erection.

.3 Bolt all field connections using specified bolts and torque to structural bolt installation specification.

.4 Install closures, trim, caps, gutters, eave, ridge and gable end members, operable vent assemblies and similar miscellaneous aluminum items and accessories as required for complete, weathertight, operable greenhouses.

.5 Hang aluminum doors and install door hardware, adjust as required for smooth, proper operation.

.6 Glazing: install glazing in accordance with the recommendations of the Flat Glass Marketing Association (FGMA) "Glazing Manual" and "Sealant Manual".

3.3 INSTALLATION OF EQUIPMENT

.1 General

.1 Install equipment in accordance with manufacturers' installation instructions and recognized industry practices to insure intended function. Equipment listed in this section 13 34 13 shall be installed by the greenhouse contractor.

.2 Examine the supporting structure and substrate for dimensions and tolerances, materials conditions, and support before beginning the installation. Carefully check provisions for anchorage and adjustment, allowances for expansion and contraction and conditions of preset flashings and flashing connections. Do not proceed until unsatisfactory conditions in affected areas have been corrected.

.3 Do not puncture or make any opening of any kind, of any size in the glass glazing of the greenhouses without written authorization by the Engineer. Any glass glazing pane perforated without such permission shall be replaced by the General Contractor at his costs, to the satisfaction of the Engineer. The General Contractor shall reposition at his costs the conduit, wire or mechanical component for which the glazing glass was perforated.

.4 Specialized systems and equipment of the greenhouse combine to create a complete environmental control system.

.5 The General Contractor shall obtain written permission of the Engineer for any significant modification.

.6 The General Contractor is responsible of all changes in his works or that of other trades caused by his modifications.

.2 Aluminum

.1 Isolation: Follow requirements of CAN3-S157-M83, 1.12, "Protection against Corrosion", where aluminum is in contact with dissimilar materials. Assume this is a wet location.

.3 Structural Steel

.1 Install greenhouses as per approved shop drawings and following manufacturer's recommendations.

.2 Maintain on file, certified copies of mill reports covering chemical and physical properties of steel used in this work.

.4 Fasteners
- .1 Anchor framing components to allow loads to be transmitted to the anchoring system.
- .2 Furnish anchor bolts and inserts at proper times for setting in concrete form work, masonry and similar work indicated to support greenhouses.

.5 Cladding System
- .1 Respect industry standards and practices while installing cladding systems.
- .2 Partition cladding system to be installed where shown on drawings, between gutter and gable columns, to allow for support overhead equipment and shade systems from both sides of the partition wall. Trusses to be accessible from either side of the partition to allow for attachment of supports for heating, lighting and other overhead equipment.

.6 Flashing and Sealing
- .1 Install flashings, membranes, ties and other accessories as required to obtain a durable perfectly watertight seal between the greenhouse structure/glazing and the service building.
- .2 Allow for differential movements of the new greenhouse with respect to the existing greenhouse.
- .3 Sealant shall be certified to be compatible with adjacent materials by sealant manufacturer, and applied in accordance with the manufacturer's recommendations.
- .4 Terminations and Junctions: Provide closure members at ridges, corners, eaves, sills and gutters, designed to connect with adjacent members and to provide weatherproof terminations and junctures. Corner junctions shall be mitered and rounded where possible. Partitions shall be fully sealed to minimize air exchange between compartments and to the corridor. Flashing details at top of partition wall, at floor slab and at access panel locations to be fully sealed and caulked, with no openings, gaps, cracks or holes.
- .5 Base wall flashing to be installed at top of curb wall with a continuous caulking joint between the top of the concrete curb and the bottom of the flashing.
- .6 Water test to be performed to confirm water tight condition of base wall.
- .7 Ridge and Sidewall Ventilators
  - .1 Install motorized units, supports and drive shafts in greenhouse, according to the manufacturer's recommendations.
  - .2 Adjust the opening of the ridge vents and sidewall vents and the limit switches so that the vents movement does not stress mechanical or structural components.
  - .3 Position limit switches to indicated maximum opening position
  - .4 Install racks under the accordion type insect screen.
  - .5 Racks must not interfere with shading cloth.
  - .6 Adjust potentiometers to report proper vent locations to the control system.
- .8 Insect screens
  - .1 Install insect screens in the openings as called for in the specifications, or shown on drawings and as per manufacturer's recommendations.
- .9 Doors and Frames
  - .1 Install doors and frames as per manufacturer's recommendations and in accordance with section 08 11 14 – Metal Doors and Frames (to be confirmed)
- .10 Shade systems
  - .1 Install shade systems as shown on drawings and as per manufacturer's recommendations.
  - .2 Ensure that shade cloth does not interfere with any components and is free of movement at all time.

.3 Install perimeter seals to maintain thermal effectiveness of shade cloth.
.4 Install vertical shades to provide full cover of the glass areas being shaded.
.5 Minimize gaps around the edges of vertical shade cloth to no more than 12mm.

.11 Benches
.1 Install benches as per manufacturer's recommendations.
.2 Bracing to be installed to maintain stability and bench location.
.3 Fasten bench legs to floor using stainless steel anchor bolts. Benches to be removable.
.4 Anchor bolt socket to be filled with stainless pan head bolts when benches are removed.
.5 Benches shall be leveled to an accuracy of +/- 3mm over the full length and width of the bench. A water level shall be used to check this.

.12 Vertical air flow fans
.1 Install fans as per manufacturer's recommendations.
.2 Adjust fan orientation, both horizontal and vertical for optimal air movement in the compartment.

.13 Evaporative coolers
.1 Evaporative cooler units to be leveled using factory mounted levelling screws and feet.
.2 Ductwork, consisting of a vibration isolation strip, made of rubber neoprene, suitable for exterior use, air tight and water tight, a duct section of galvanized sheet metal, a duct elbow and a diffuser with a thrip screen box lead the cooled air to the greenhouse space. Ductwork to be of heavy galvanized duct sheet metal.
.3 Connect water line to cooler units.
.4 Install coolers as per manufacturer's recommendations.
.5 Install purge valves, make overflow and purge connections and connect to PVC condensate lines.
.6 Run condensate lines to hub drains in basement corridor.
.7 No vibration must be transferred to ductwork penetrating into the greenhouses when coolers are operating.
.8 Seal duct penetrations at floor slab and concrete curb walls using approved sealant and trim angles.

.14 Lighting supports
.1 Install the support system and support rails as shown on drawings.
.2 Rails to be attached to structure respecting spacing specified on drawings.
.3 Installation of light canopies to match with canopies of existing greenhouses.

.15 Supplemental Lighting Fixtures
.1 Install fixtures as per manufacturer's recommendations.
.2 Each connector and each luminaire must be independently well identified, tested and verified to the Engineer's satisfaction.

3.4 COMMISSIONING, STARTUP AND INSTRUCTION

.1 Provide commissioning services upon startup, in accordance with sections 01 91 00, 01 91 31. This includes proving all input and output points, all equipment and all greenhouse systems. A detailed checklist shall be submitted with the Operation and Maintenance.

.2 Commissioning services to include, but are not limited to:
.1 Adjust all doors and door hardware for proper operation,
.2 Adjust vents for tight closure,
.3 Adjust shade system for smooth operation and full closure,
.4 Adjust vent and shade motor limit switches,
.5 Adjust and mesh vent potentiometers,

.6 Fill and start evaporative coolers and set diffuser guide vanes for even air flow throughout the compartment,
.7 Adjust motor sheaves to achieve manufacturer recommended rotational speed,
.8 Adjust benches for smooth operation,
.9 Start and adjust vertical air flow fans and horizontal air flow fans,
.10 Record current draws for all electrical equipment,
.11 Record manual operation of each piece of equipment under computer control,
.12 Record computer override operation of each piece of equipment under computer control,
.13 Program and record control sequence for each environmental zone by cycling and logging a full range of temperature, humidity, light and watering control events,
.14 Provide and check equipment identification, including equipment tags and labels.

.3 Provide user instruction and instruction for maintenance personnel in all greenhouse components, equipment and systems and their integrated operation.

3.5 ADJUSTING AND CLEANING

.1 General: after construction is complete, clean aluminum surfaces removing dirt, glazing compounds and other substances from exposed surfaces. All surfaces, including glass, shall be handed over in a clean condition, with all foreign materials, labels, stickers, contaminants marks or scuffs removed. Glazing labels shall be removed from glass surfaces.

.2 Repair all marred or scratched surfaces of factory finished equipment, using finish materials furnished by the manufacturer.

.3 Adjust doors and hardware after installation for proper operation

.4 Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

.5 Cleaning to be performed as per requirements indicated in sections 01 74 11 and 23 08 02. Keep concrete dust off aluminum structure.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 91 00 –Commissioning

.3 Section 13 34 13 – Greenhouse Structure and Specialties

.4 Section 23 13 01 – Greenhouse Mechanical

.5 Division 26 – Electrical

1.2 SUBMITTALS

.1 Supply list of complete technical specification for control system and equipment supplied.

.2 Supply list of control settings and parameters as well as examples of graphic display

.3 Supply specifications of the data logging capacity, (format, duration, selection)

.4 Supply statement about greenhouse control system supplier's policy for the on-site configuration and start-up of the system, according to particular requirements of this research center.

.5 Submit required submittals in accordance with Section 01 33 00 – Submittal Procedures.

.6 Coordinate final electrical equipment panelboard short circuit AIC ratings with Division 26. Electrical panelboards shall be submitted subsequent to the fault current and coordination studies required in 260 5 73 (to be confirmed). Equipment submittals prior to the required study shall not be reviewed by the Design Engineer and will be returned "rejected.

.7 Product data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each product and system used.

.8 Submit manufacturer's certifications stating that products and systems comply with requirements. List and describe features of control systems, performances and operating characteristics.

.9 Manuals: Operation and Maintenance Manuals, in accordance with Section 01 78 00 – Closeout submittals, listing operating and maintenance instructions, emergency Instructions, safety considerations, parts listings, exploded views, parts sources and circuit diagrams.

1.3 SHOP DRAWINGS

.1 Shop drawings must include, but not be limited to, the following;

.2 Submit shop drawings for fabrication and installation of the greenhouse computer control system, and placement of all components supplied under this Section.

.3 Show and provide details of supports required and wiring runs for all low voltage connections.

.4 Technical sheets including schematic diagrams for the controllers and weather station (existing).

.5 Technical sheets for all sensors supplied.

.6 Terminal wiring schedules for all cabinets.

.7 Schematic diagrams of complete system, and of each cabinet with field connection.

.8 All identified with name of equipment and tag number as shown on the load list shown at the end of this section. No external motor starters or external relays shall be shown on those drawings. Output terminals shall state "TO -.__", "TAG#, NAME".

1.4 WARRANTY

.1 As per prescription of Division 01 – General Requirements.

1.5 SYSTEM DESCRIPTION

.1 The computerized control system is to be an expansion of the existing control system, it shall be provided and made for control of specialized greenhouse equipment and must accomplish the following:

.1 Narrow setpoint deviation tolerances over the wide span of possible climate conditions required for various horticultural applications ; root and leaf zone temperature control ; evaporative cooling & humidification ; dehumidification and condensation control ; evapotranspiration, humidity levels, and vapor pressure deficits within crop canopies ; monitoring and control ; management of light intensities, supplementary illumination and illumination periods (shade control systems, high intensity discharge lighting, & cyclic crop lighting) ; horizontal and vertical shade, blackout and thermal curtain management ; irrigation (capacity, feed selection, delivery, and recovery management) ; mist & fog propagation ; user-definable output control programs for research and other special applications ; plant nutrient monitoring, dosing, and control ; safety overrides for wind, boiler shock, rain, snow detection, high light intensity, etc. ; global, multi-system overrides for spraying, snow melting, etc. ; modulating roof vents (based on indoor/outdoor temperatures, humidities, light levels, wind direction, and wind intensity) ; water chemistry management ; nutrient and pH control Water volume management: ; multiphase environmental setpoints matched to crop growth stages; dynamic supplemental lighting control ; demand based irrigation scheduling ; solar energy management ; light intensity modeling.

.2 The control system is to be designed in accordance with the latest advancements in greenhouse control, with the objective of regulating the environmental plant growth factors, collecting and processing data in view of scientific research. All functions described herein shall be accessed through a central computer.

.3 The control system take all control parameters into consideration to determine the appropriate operating conditions and sequences of the different mechanical systems to best maintain the desired setpoints.

.4 The system shall allow for variable setpoints as a function of the control parameters as commonly found in industry practice and in accordance with the latest research in greenhouse control.

.5 The greenhouse computer control systems shall be single purpose, dedicated central or distributed control systems, specifically designed for greenhouse use and manufactured and supported by a company specializing in this field.

.6 Software and firmware shall be included with the package and must be specifically written for controlling and monitoring the greenhouse environment and associated subsystems.

.7 The greenhouse control package shall include relay interface cabinets and circuit breaker protection and branch circuit protection which are fed from distribution panels in the headerhouse electrical room.

.8 The relay interface cabinets switch all connected loads and include reversing motor starters and thermal overload devices, and general purpose relays as outlined in the points list, list of electrical panels and electrical loads list.

.9 Lighting relay cabinets shall be supplied, two for the new greenhouse wing (east and west).

.10 Low voltage devices that are controlled by the computer (e.g. hydronic hot water heat mixing valves, irrigation solenoid valves) may be connected directly to the computer output section, as appropriate.

.2 Greenhouse computerized control system must have the capabilities to:

.1 Control of all mechanical systems in all greenhouses shown on drawings as well as mechanical systems common to all greenhouses.

.2 The load/control point list shown at the end of this section identifies all the elements to be controlled.

.3 Each greenhouse control is independent from the others.

.4 Setpoints are required for air temperature, air-moisture content and light levels.

.5 Monitoring outside and inside climatic conditions with visual, audible and printed alarm capabilities.

.6 Storage of readings of the various sensors in formats that can be programmed by the Users.

.3 The system shall have a programmable start up sequence to permit starting of greenhouse equipment compartment by compartment.

.1 The sequence will be initiated at each power up and after a power failure during the time the greenhouses are powered by the emergency generator. This is in order to minimize overloading the generator on starting.

.4 The system shall have load management capabilities and normal and standby power monitoring.

1.6 CERTIFICATIONS

.1 All electrical equipment and components must be CSA approved

.2 All panels must bear a CSA stamp (Shop approved, LR NUMBER).

1.7 DELIVERY, STORAGE AND HANDLING

.1 Protect materials during delivery, storage and handling to comply with manufacturers' directions and as required to prevent damage and deterioration, in accordance with Section 01 61 00 – Common Product Requirements. Store conduit, panels and enclosures away from rain, snow and condensing conditions.

1.8 GREENHOUSE COMPUTER CONTROL SYSTEM MANUFACTURER

.1 As this new control system is to be an expansion of the existing control system (wing 4), it shall be provided by: Argus Control Systems Ltd.

Part 2 Products

2.1 COMPONENTS

.1 Computer Control Systems
- .1 Computer control systems, operator, sensor packages, motor reversing relays, branch circuit protection, lighting contactors, fan and pump relays, irrigation solenoid valve relays, switched receptacle relays and commissioning, startup and user instruction.
- .2 Allow for 6 spare outputs and 4 spare inputs per zone. The spare outputs are to be user programmable or activated free of charge within 1 year, to be assigned to any of the program modules.
- .3 The spare outputs are to be provided with 10A general purpose DPDT cube relays in the related Relay Control Panels.
- .4 The spare inputs are to be user programmable or activated free of charge within 1 year, to be assigned to any of the program modules.

.2 Environmental control system for the greenhouse complex
- .1 GH functions:
- .2 Per attached Points Lists in Appendix 1.
- .3 General purpose outputs (switched receptacles and spare outputs) are to be assignable to any of the program modules. Some examples are: bench heat, ebb and flow sump pump, local irrigation water circulator pump, shaker table, daylength extension lighting, fog systems. The software necessary must either be resident in the delivered package and configurable by the user or be activated and configured free of charge within 1 year of total performance of the contract.
- .4 General purpose inputs (spare inputs) are to be assignable to any of the program modules. Some examples are: CO2 sensors, additional soil temperature sensors, additional light sensors, additional temperature sensors. The software necessary must either be resident in the delivered package and configurable by the user or be activated and configured free of charge within 1 year of total performance of the contract.

.3 Global functions:
- .1 Per Attached Points List in Appendix 1.
- .2 See 1, above for requirements for general purpose outputs and inputs.

.4 Control Points List
- .1 The Control Points list should contain all of the intended control points in a detailed list complete with drawings. The specification controls points list is as shown in appendix 1. The contractor will provide a Control point list for construction based on the Submitted Control Points list and on the information provided in the drawings.

.5 System Components
- .1 Operator Interface Terminal: Using the existing desktop computer located in greenhouse managers office.
- .2 Distributed Control Units (Distributed Control Option): Located in greenhouse corridor, by compartment doors, one per compartment, and 2 in greenhouse basement to control lighting, location shown on drawings. Corridor functions to be included in units at center of corridor.
- .3 Enclosed in aluminum NEMA 4 cabinets, CSA approved.
- .4 Each output point to be provided with manual override switches (on/off/auto or open/close/stop/auto, as appropriate).
- .5 Distributed Control Units and Relay Control Panels shall be combined.
- .6 Cabinets to be equipped with locks.

.6 Relay Control Panels: Located in greenhouse corridors, adjacent to the zones. NEMA 4 cabinets, CSA or ULC approved.

.1 Include branch circuit protection in relay control panels.
.2 Reversing motor starters to be mechanically and electrically interlocked and provided with adjustable thermal overload devices where called for in the Points Lists in the Appendix.
.3 Note that Branch Circuit Breakers, Distributed Control Units and Relay Control Panels shall be combined.
.4 Cabinets are to be equipped with locks.
.5 Cabinets to have disconnect switches interlocked with the cabinet doors.
.6 Circuit breaker panelboards shall be fully rated and have minimum short circuit current of 22,000 AIC.
.7 Series rated circuit breakers shall not be accepted.
.8 Main bus bars shall be copper sized as required by CSA standards to limit temperature rise on current carrying parts to 50°C above ambient 40°C maximum.
.9 Main bus bars shall be sized at least to full rating of feeders overcurrent device that feeds the panelboard.
.10 Provide molded case, bolt-on, thermal-magnetic trip, single, two or three pole branch circuit breakers.
.11 Multiple pole breakers shall be single handle, common-trip. Circuit breakers shall be listed and labeled for 75°C conductor ampacities.
.12 Panelboards served by K-rated transformers shall have neutral bus sized for 200% rated neutral conductors. Neutral bus shall be isolated from panelboard tub
.13 Provide separate equipment ground bus for each panelboard.
.14 Provide typed panelboard directories that show use of each circuit and electrical characteristics of panelboard.
.15 Panelboard designations shall be labeled on the front of the panel with a screw-on nameplate, and on the directory.
.16 Provide HID rated breakers in lighting panels and 20A circuits.

.7 Sensors:
.1 Supply sensors along with calibration data, gas or liquids (whichever is required), as well as installation, calibration and maintenance instructions.
.2 Supply all additional components required to suspend, hold or anchor sensors. All support components are to be made of galvanized steel, aluminum or plastic material of sufficient rigidity.
.3 Supply all the sensors, as shown on Load/control point list in appendix 1.
.4 Aspirated zone sensors boxes:
.1 Aspirated zone sensor boxes are to contain a primary air temperature sensor, a solid state RH sensor, a CO2 sensor, a PAR light sensor and a secondary air temperature sensor.
.2 Aspirated box (24 VAC ventilator), with a support chain for installation in the greenhouse and must be adjustable in height.
.3 Dry bulb temperature sensor: shall have a ± 0.1°C of accuracy.
.4 Relative humidity sensor: Aspirated Bulk-polymer resistance humidity sensor. Accuracy: ±2% 5-95% RH, Operating temperature: -60°C to 85°C.
.5 Weather station: control system to use data from existing weather station.
.6 Pipe sensors for hot water heating system: sensors may be strap-on surface mount, to be installed under the pipe insulation.
.7 CO2 sensors shall be non dispersive infrared. The diffusion gas chamber in the sensor should incorporate a gold plated reflective light pipe or wave guide surrounded by a gas permeable teflon based hydrophobic diffusion filter that prevents particulate and water contamination of the sensor. Sensor is to be provided with a 5 year calibration guarantee. The sensor shall provide simultaneous analog outputs in volts and milliamps and shall have a gold bifurcated relay that can be operated as normally open or closed. The sensor shall incorporate elevation correction adjustment and have an accuracy of +/- 50 ppm or 5% (7% for levels over 1500 ppm) at temperature of 15-32°C. All adjustments to

the sensor including output scaling, elevation adjustment, relay setpoint, relay dead-band, proportional or exponential output, and single-point calibration shall be made via computer connected to an on-board RJ45 jack, or via the proprietary communication network.

.8 Alarm outputs to be available on a compartment by compartment basis as well as one general programmable alarm for each of the three whole systems.

.9 Lighting Control Panels: Located in the greenhouse basement corridor.
- .1 NEMA 4 cabinets, CSA approved.
- .2 Panels to contain computer interfacing, contactors for 347V ballast lighting fixtures and HAND/OFF/AUTO override switches to control lights on a bench-by-bench basis.
- .3 Switches to be front panel mounted, switching line voltage to lights on individual benches. Function: HAND-lights are ON regardless of control status. OFF-Lights are OFF regardless of control status. AUTO-lights respond according to control status.

2.2 SOFTWARE – GENERALITIES

.1 Greenhouse and irrigation control to be resident in distributed controllers.

.2 Control of all equipment to be integrated to result in stable and consistent environmental control under widely varying conditions.

.3 Irrigation solenoid valves and computer switched receptacles to be user programmable, as are spare outputs and inputs.

.4 In addition to the spare outputs and inputs, appropriate software for greenhouse controls and operations must also be provided to allow future use and for flexibility (for example, carbon dioxide level software).

.5 Connect to existing Argus network and access point. Add new zones to the existing operator interface terminal display, data logging and archiving.

.6 Data logging and archiving to allow logging of all sensor readings and setpoints at intervals not exceeding 10 minutes. Logging of equipment on/off cycles and operation duration is required.

.7 Settings to be saved on a compartment by compartment basis, to allow reloading at a later date. Multiple setting files are to be supported (e.g. spring, summer, winter, fall, or User A, B, C ...). Setting files to be loaded across compartments or copied from compartment to compartment.

.8 Password access to the system is to be granted at various levels by the greenhouse manager. These levels must include at a minimum, read only single zone, read only multiple zones, read and change settings single zone, read and change settings multiple zones, global access. Restricted access to portions of the settings is required (e.g. irrigation only, sensor readings only, and the like.), in single or multiple zones. Password access to allow for a minimum of 20 users, each with individual access profiles.

.9 Alarms are to be user programmable. Any sensor reading, derived parameter or status code is to be programmable as an alarm condition, either by comparison with an absolute number or as a relative number (e.g. zone temperature greater than 35°C or zone temperature more than 5°C above ventilation target temperature. A minimum of 4 alarm levels to be provided: silent (logged only), zone alarm by buzzer or bell, general alarm by

buzzer of bell, activate telephone dialer. Each zone to have a minimum of 10 programmable alarm conditions. Buzzer or bell to be located in the greenhouse central corridor.

.10 Factory support to be available on line. This may be Internet support, at the discretion of the User. Support to be from the manufacturer's location and is to be available during normal business hours. Emergency after hours and weekend support is required. Telephone support to be provided, free of charge, for a minimum of 2 years.

.11 On-line help is to be provided, either resident in the operator interface terminal software or by Internet.

.12 Software to be upgraded, free of charge, for a 2 year period.

2.3 SOFTWARE – GREENHOUSE CONTROL

.1 The greenhouse control software shall be capable of maintaining the desired set points while operating all mechanical systems such that variations in the environmental conditions are optimal for plant growth.

.2 The relative effects and interactions between heating, ventilation, shading system and high intensity lighting, must be integrated in all circumstances, to best maintain the desired setpoints.

.3 The control system shall provide all required interlocks for the mechanical system commonly found in a greenhouse.

.4 Each greenhouse compartment of the research complex shall be equipped with the control software for that particular greenhouse compartment.

.5 There will be 6 new greenhouse compartments in the new addition, 1 new corridor, 1 new basement and 2 new dog house sections.

.6 Depending on the configuration of the system, there will be 10 copies of the same software or only one software package able to address all 6 greenhouses and 4 additional spaces in an independent fashion and without limiting in any way the interactions of all and any software of a single greenhouse.

.7 Temperature control software shall include, but not be limited to, the ability to vary up to eight setpoints with automatic ramping between set points based on the time between the end of one period and the start of the next. Start and end times can be assigned anywhere in the 24 hour period. Set points may be a function of:

.1 Actual, average or accumulated outdoor light levels.
.2 Actual, average or accumulated indoor temperature.
.3 Any other measured values including accumulated values as calculated by either internal or external growth modeling applications.
.4 Night setpoint as function of a required 24 hour average temperature with the day setpoint varying as a function of PAR light level.
.5 User programmable anticipation period.
.6 Hysteresis control (deadband control).

.8 Heating control software:

.1 Control of the upper level finned tubing to setpoint or as a function of the roof snow melt needs. If weather station detects snow, all compartments and corridors shall be capable of operating in snow melt mode.

.2 Possibility of maintaining a minimum pipe temperature, set by the users in the upper level finned tubing.
.3 Control for perimeter heating loops in each compartment.
.4 Heating in the greenhouses is done with hot water through finned tubes. The control system will modulate the 3-way control valves. Control valve modulation is done according temperature differentials (interior, exterior), actual temperature versus setpoint and other control strategies may also be considered based on the suppliers' experiences with those type of systems.

.9 Ventilation control software:
.1 Unless prevented by interlocks with other systems whose set-points create conflicts with the present the control sequence for ventilation should be as follows:
.1 Natural ventilation
.2 Evaporative coolers 1st speed
.3 Evaporative coolers 2nd speed
.4 Evaporative coolers pad pump

.10 Shade screen (override shade control parameter for minimum light level if required by users).

.11 Transfer dampers, per existing control settings.

.12 Ventilation fans, per existing control settings.

.13 Roof vent opening for natural ventilation is to be controlled and modulated. Vent position is to be determined and set by run time of the vent motor required for 100% opening.
.1 Potentiometers are to be supplied, to provide vent position feedback to the control system.
.2 The existing weather station gives data upon the wind direction and velocity. Depending of the wind direction and velocity, adjustments are to be done to the ridge vent positions, to provide optimal natural ventilation, to avoid wind damage to the ridge vents and to minimize rain infiltration. When the wind comes from the westerly quadrant, east vents shall be lead while west vents shall follow, when ventilation is called for. During rain or snow conditions, or in windy conditions, the control system shall limit ridge vent positions to reduce water penetration into the greenhouses. Corrections on ridge vent positions, according wind direction and velocity shall be user programmable. Roof vents shall be limited when the outside temperature goes below a user selectable threshold temperature range

.14 Horizontal air flow fans:
.1 Provide manual speed controller (one controller per compartment), to be located in the appropriate control panel.

.15 Include all interlocks required between ventilation, heating, humidity control, shade control.

.16 Allow for day night temperature differential control (DIF).

.17 Air moisture content software shall integrate the heating, ventilation to increase or decrease air moisture content. The software shall include, but not be limited to, the following items.
.1 Four setpoints: morning, midday, evening, night.
.2 Automatic and gradual change between day, night and evening set-points
.3 Set-point based on relative humidity.
.4 Set-point based on a fixed vapor pressure deficit or a vapor pressure deficit profile.

.5 Allow for a fixed humidity set point to override temperature setpoints between fixed temperature limits.
.6 Setpoints are to be variable as a function of light and/or time
.7 Interact and interlock with the temperature control and shade screen and software as required.

.18 Lighting control software:
.1 Shall include an adjustable delay between lighting of individual zones.
.2 Control also to incorporate compensation for variation in natural light levels due to passing clouds.
.3 Setpoints and control parameters to be.
.1 Time (start-stop at set times).
.2 Natural light levels. Lighting is on when natural light levels are below a given level which is user definable.
.3 A combination or .1 and .2.
.4 As a function of the total light energy received daily (DLI).
.5 Compensation during the night as required.
.6 On the basis of a required photoperiod.

.19 Shade curtain control software:
.1 Based on ambient light levels and temperature, with the possibility of partial opening when ventilating.
.2 The software shall control the horizontal and vertical shade systems.
.3 Shade operating setpoints required are:
.1 Time (start-stop at set times).
.2 Natural light levels. The curtain is to be opened when the natural light level falls below a level set by the user or the curtain is to be extended when the light exceeds a level set by the user.
.3 Temperature. The shade curtain is used to reduce solar gain in conjunction with the ventilation system.
.4 Energy conservation. When the exterior temperature drops below a given level at night the curtains are drawn for energy conservation. Curtains are opened afterwards at a gradual rate.
.5 Evaporative cooler and ventilation override: the shade curtain position is to be readjusted to allow for air flow through the ridge vents during summer ventilation mode.

.20 Irrigation control software:
.1 Shall accommodate drip irrigation and mist irrigation with and without fertilizer injection. The setpoints and control parameters required are:
.1 Time (start-stop at fixed times).
.2 Integrated light energy.
.3 Elapsed time.
.4 Water potential.
.1 Maximum irrigation flow. In order to limit the demand on tempered water for irrigation the maximum number of irrigation valves to operated simultaneously shall be user adjustable.
.2 Irrigation software shall also allow water analysis, water treatment, water fertilization and water recirculation capabilities.

2.4 SOFTWARE – CORRIDOR AND BASEMENT

.1 Per existing controls

2.5 SEQUENCES OF OPERATIONS

.1 These sequences of operation represent a starting point for system delivery and commissioning. The sequences are to be modified by the engineer and the users. The control system shall accommodate the described sequences and shall allow for any other sequences programmed by the users. At time of start-up, those sequences given shall be verified.

.2 Greenhouse compartments

.1 Heating mode

.1 The indoor and outdoor air temperature are both in equilibrium, only HAF fans are running, to allow good homogeneity in the air temperature within the greenhouse compartments. The manual speed control may be used to reduce the speed and sound level of the fans.

.2 On an outdoor temperature fall and in anticipation of a temperature fall inside the greenhouse:

.1 1st stage: The perimeter heating loop shall be used to meet the actual and anticipated demand by varying the hot water temperature into the loop with the three way control valves (heating loops operate with constant water flow and variable hot water temperature).

.2 2nd stage: When the perimeter heating loop is operating fully or at a definable percentage of maximum capacity, the upper-level heating shall be used to meet the actual and anticipated demand by varying the hot water temperature into the loop with the three way control valve. The percentage of maximum capacity is to be interlocked with the requirements of the compartment with the minimum temperature set-point.

.3 Snow-melting capability: Upper-heat shall be used for snow melt with a definable maximum air temperature interlock. Snow melt will be a function of definable level of precipitation. If weather station detects snow, user identified compartments shall go into snow melt mode.

.2 Cooling mode

.1 The indoor and outdoor air temperature are both in equilibrium, only HAF fans are running, to allow good homogeneity in the air temperature within the greenhouse compartments. The manual speed control may be used to reduce the speed and sound level of the fans.

.2 On an outdoor temperature rise and in anticipation of a temperature rise inside the greenhouse:

.1 1st stage: The ridge and sidewall vents start to open and gradually continue until fully open on east and/or west sides or both, depending on wind speed, wind direction and presence of rain.

.2 The actual ridge vent position shall be based on the user programmable position settings and readings of the position sensor. Hot air escapes from the top of greenhouse.

.3 2nd stage: If the temperature continues to rise for a programmable amount of time after the ridge and sidewall vents have reached their user set maximum position (with the appropriate weather station overrides), the evaporative cooler fans shall start at low speed.

.4 3rd stage: When the temperature continues to rise or in anticipation of a temperature rise, coolers are switched on second speed in each zone, thus increasing the flow of exhausted air.

.5 4th stage If temperature still rises or in anticipation of a temperature still rising, cooling pad pumps start in appropriate greenhouse compartments. Water keeps the pad material wet. As long as there is an evaporative cooling demand in a greenhouse compartment, the appropriate pump runs.

.6 5th stage: Finally, if the temperature continues to rise, the shade system shall be made to completely close with all other ventilation and

cooling/humidifying systems operating. This shall continue until alarm condition is reached. On cooling alarm, optional settings shall allow the control to revert to natural ventilation (ridge and sidewall vent) mode.

.3 Shading systems
- .1 Horizontal shade system: The shade system shall be used for temperature control as indicated above in the cooling mode. When used in conjunction with natural ventilation the shade shall be closed partially (this position to be user adjustable) to allow ventilation air flow. The shade shall also be used for energy conservation and closed at night during the heating period. Upon opening in the morning the shade shall be opened with small increments (100 mm) with user set delays to prevent cold air shock on the plants. The shade curtain shall be forced open when snow melt is required.
- .2 Vertical shade: The vertical shade system is used for temperature control, by reducing the solar heat gain factor through side east/west side walls and north/south gable end walls.

.4 Lighting system
- .1 Supplementary lighting shall be for plant growth, daylength extension and photoperiod control.
- .2 The control system shall also provide start-up delays to prevent cycling of the lights when clouds pass.
- .3 The control system shall also provide sequenced lighting start-up to prevent overloads on the electrical system.

.5 Irrigation
- .1 Irrigation in greenhouses is controlled either by solenoid valves in each zone or by electrical duplex service outlets connected to the control system. Drip, mist or any other irrigation devices may be subsequently installed and controlled through these irrigation valves or electrical duplex service outlets.

.6 Relative humidity level
- .1 Increasing RH: No provisio
- .2 Decreasing RH: In cooling mode, cooling pumps stop to decrease RH. Heat is to be boosted to decrease RH.
  - .1 Dehumidification in all greenhouse compartments shall be secondary to temperature set-points.

.3 Greenhouse corridors
- .1 Heating mode: The indoor and outdoor air temperature are both in equilibrium, No action.
  - .1 On an outdoor temperature fall and in anticipation of a temperature fall outside the corridor:
  - .2 The upper-level heating shall be used to meet the actual and anticipated demand by varying the hot water temperature into the loop with the three way control valve. The percentage of maximum capacity must be interlocked with the requirements of the corridor with the minimum temperature set-point.
  - .3 Snow-melting capability: Upper-heat shall be used for snow melt with a definable maximum air temperature interlock. Snow melt will be a function of definable level of precipitation. If weather station detects snow, corridor should go into snow melt mode.
- .2 Cooling mode: The indoor and outdoor air temperature are both in equilibrium.
  - .1 On an outdoor temperature rise and in anticipation of a temperature rise outside the corridor:
  - .2 1st stage: The ridge vents start to open and gradually continue until fully open on east, and/or west sides or both, depending on wind speed, wind direction and presence of rain. The actual ridge vent position shall be based

on the user programmable position settings and readings of the position sensor. Hot air escapes from the top of greenhouse.

.3 No humidification control is available in the greenhouse corridors.

.4 Fire alarm: upon fire alarm in the greenhouses, shut down evaporative cooler fans.

Part 3 Execution

3.1 PREPARATION

.1 Examine areas and conditions where greenhouse electrical work is to be installed. Notify general contractor in writing of conditions detrimental to proper and timely installation of work.

.2 Coordinate the complete electrical installation of line voltage branch circuitry and empty control conduit requirements with the Division 26 contractor prior to commencement of the installation.

3.2 COMMISSIONING, STARTUP AND INSTRUCTION

.1 Provide complete coordination, commissioning, startup and instruction, in accordance with Section 01 91 00 –Commissioning (Cx) and Section 01 91 31 – Commissioning (Cx) plan.

.2 Provide commissioning services upon startup. This includes proving all input and output points, all connected equipment and all controlled greenhouse systems.

.3 All the tests identified in this section will be demonstrated to the Engineer.

.4 Test and calibrate every sensor, using NIST calibration sensors. Record deviations from standard sensors. This may be done at the factory.

.5 Test and cycle every output, by operating manually with the manual override switch, followed by computer software equipment override section, followed by programmed sequence under full computer control. Record results of each level of test and corrective action taken.

.6 Measure current draw of each piece of equipment connected to the computer control system and adjust the thermal overload device associated with the piece of equipment. Record the measured current and the setting of the thermal overload device.

.7 Test and operate the communications network.

.8 Test and operate the central alarm system. Program and confirm operation of the telephone dialer. Program and confirm the single point alarm interface to the building management system.

.9 Test, configure and operate the operator interface terminal, including the user setpoint changes section, the data logging and graphic data display section and the remote communications section.

.10 Configure the password access control section, to the satisfaction of the Engineer.

.11 Test and operate the remote dial up feature by connecting to the computer manufacturer's service center.

.12 Retest and calibrate the weather station, as per sensors above.

.13 Test recovery of the system from a power failure. Record results of startup sequence, including delay on restart of supplemental lighting.

.14 A detailed checklist shall be submitted with the Operation and Maintenance manual.

3.3 TRAINING

.1 Provide training in accordance with section 01 79 00 – Demonstrating and Training.

.2 Provide user instruction and instruction for maintenance personnel in all greenhouse computer control components, equipment and systems and their integrated operation.

.3 A minimum of 3 days on site are to be provided, for startup and commissioning, split between two separate site visits. Timing of site visits to be coordinated with the engineer, the mechanical and the electrical contractors.

.4 A minimum of 2 user instruction sessions are to be given, one at startup time and one 4 – 6 months later. Each user instruction session is to be 4 hours long. Instruction sessions to be given by person competent in this field.

3.4 EQUIPMENT SCHEDULES - LOADS/CONTROL POINTS LIST

.1 Refer to the Appendix 1 for listings and electrical characteristics of equipment to be controlled, 2 pages.

APPENDIX 1 – LOAD/CONTROL POINTS LIST (2 pages)

AAFC-HARRINGTON, PEI
Greenhouse Extension
AT 09-Oct-15
R1 01-Nov-15

Ref.	Location				Identification		Description	Qty	Load Details								Output					Input		
	Headerhouse	Corridor	Basement	Greenhouse	Identification		Description	Qty	Voltage	Load	Amps	VA	TOTAL-VA	Thermal Overload	Emergency	Elevation (mm)	ON/OFF	START/STOP	OPEN	CLOSE	OPEN/CLOSE	ANALOG INPUT	ANALOG OUTPUT	Comments
					New greenhouses																			
					Large Compartments:		2																	
1				•	L1-	RVM-W	West Ridge Vent-1 (Open/Close)	1	208 - 3Ph	110 W	0.8 A	288 VA	288 VA	•	•	6000					•			ridder RW-45 - 2RPM
2				•	L1-	RVM-E	East Ridge Vent-1 (Open/Close)	1	208 - 3Ph	110 W	0.8 A	288 VA	288 VA	•	•	6000					•			ridder RW-45 - 2RPM
3			•		L1-	EC-1-3	Evaporative cooler-1-TWO SPEED	3	208 - 3Ph	1.5/0.38 HP	4.8 A	1727 VA	5182 VA	•		-3000		•						1st Speed, 2nd Speed, 2 control pts/comp. 4.8 A on high
4			•		L1-	ECMD-1-3	Evaporative Cooler Motorized Damper	3	120 V	8 A		500 VA	1500 VA			-3000			•	•				
5			•		L1-	ECP-1-3	Evaporative Cooler Pumps - 2 each	3	120 V		2.4 A	288 VA	864 VA	•		-3000		•						
6				•	L1-	TLMD-1-3	Air transfer damper 1-3	3	120 V	4VA		4 VA	12 VA			3500			•	•				located at corridor wall
7				•	L1-	HAF-1	HAF Fan-1	1	115 V	75 W	1.3 A	150 VA	150 VA			3500		•						2 fans run at the same time
8				•	L1-	HAF-1	HAF Fan-2	1	115 V	75 W	1.3 A	150 VA	150 VA			3500								VT12-PA, 1/10hp, 1.3 amp, 115 V
9				•	L1-	PPF-1-2	Positive Pressure Fan 1-2	2	120 V	1/4 hp	3.5 A	420 VA	840 VA		•	3500		•						one control point per zone
10				•	L1-	PPMD-1-2	Positive Pressure Motorized Damper-1-2	2	120 V	4VA		4 VA	8 VA		•	3500			•	•				
11				•	L1-	RSM	Roof Shade Motor	1	120 V		2.7 A	324 VA	324 VA	•	•	4300					•			roof shade: PH-30/14, 120V, 2.7amps
12				•	L1-	VSM	Vertical Shade Motor	1	120 V		1.8 A	485 VA	485 VA			4300	•							
13			•		L1-	P1	Overhead Circulating pump	1	120 V	250 W	2.2 A	260 VA	260 VA		•	-300		•						UP-26-99
14			•		L1-	MV1	Overhead Control Valve	1	120 V	50 W	0.4 A	48 VA	48 VA		•	-300			•	•				
15			•		L1-	P2	Perimeter Circulating pump	1	120 V	250 W	2.2 A	260 VA	260 VA		•	-300		•						UP-26-99
16			•		L1-	MV2	Perimeter Control Valve	1	120 V	50 W	0.4 A	48 VA	48 VA		•	-300			•	•				
15				•	L1-	IV-1-5	Irrigation Valve-1-5	5	24 V	12 W	0.5 A	12 VA	60 VA			760					•			One valve per bench, 7901, Nelson, 24VAC, 0.5amps, 12W
16				•	L1-	SL-1-2	Service Lighting-1-2	2	120 V	60 W	0.3 A	36 VA	72 VA		•	4500								Switch by door, vapourproof globe lamp with CFL lamp
17				•	L1-	CP-1	Control Panel-1	0.5	120 V	500 W	4.3 A	516 VA	516 VA		•	760								
												SUB-TOTAL:	11354 VA											Each of 2 large compartments
					Medium Compartments:		4																	
18				•	M1-	RVM-W	West Ridge Vent-1 (Open/Close)	1	208 - 3Ph	110 W	0.8 A	288 VA	288 VA	•	•	6000					•			ridder RW-45 - 2RPM
19				•	M1-	RVM-E	East Ridge Vent-1 (Open/Close)	1	208 - 3Ph	110 W	0.8 A	288 VA	288 VA	•	•	6000					•			ridder RW-45 - 2RPM
20			•		M1-	EC-1-2	Evaporative cooler-1-TWO SPEED	2	208 - 3Ph	1.5/0.38 HP	4.8 A	1727 VA	3454 VA	•		-3000		•						1st Speed, 2nd Speed, 2 control pts/comp. 4.8 A on high
21			•		M1-	ECMD-1-2	Evaporative Cooler Motorized Damper	2	120 V	8 A		500 VA	1000 VA			-3000			•	•				
22			•		M1-	ECP-1-2	Evaporative Cooler Pumps - 2 each	2	120 V		2.4 A	288 VA	576 VA	•		-3000		•						
23				•	M1-	TLMD-1-2	Air transfer damper 1-2	2	120 V	4VA		4 VA	8 VA			3500			•	•				located at corridor wall
24				•	M1-	HAF-1	HAF Fan-1	1	115 V	75 W	1.3 A	150 VA	150 VA			3500		•						2 fans run at the same time
25				•	M1-	HAF-1	HAF Fan-2	1	115 V	75 W	1.3 A	150 VA	150 VA			3500								VT12-PA, 1/10hp, 1.3 amp, 115 V
26				•	M1-	PPF	Positive Pressure Fan	1	120 V	1/4 hp	3.5 A	420 VA	420 VA		•	3500		•						one control point per zone
27				•	M1-	PPMD	Positive Pressure Motorized Damper	1	120 V	4VA		4 VA	4 VA		•	3500			•	•				
28				•	M1-	RSM	Roof Shade Motor	1	120 V		2.7 A	324 VA	324 VA	•	•	4300					•			roof shade: PH-30/14, 120V, 2.7amps
29				•	M1-	VSM	Vertical Shade Motor	1	120 V		1.8 A	485 VA	485 VA			4300	•							
30			•		M1-	P1	Overhead Circulating pump	1	120 V	250 W	2.2 A	260 VA	260 VA		•	-300		•						UP-26-99
31			•		M1-	MV1	Overhead Control Valve	1	120 V	50 W	0.4 A	48 VA	48 VA		•	-300			•	•				
32			•		M1-	P2	Perimeter Circulating pump	1	120 V	250 W	2.2 A	260 VA	260 VA		•	-300		•						UP-26-99
33			•		M1-	MV2	Perimeter Control Valve	1	120 V	50 W	0.4 A	48 VA	48 VA		•	-300			•	•				
32				•	M1-	IV-1-3	Irrigation Valve-1-3	3	24 V	12 W	0.5 A	12 VA	36 VA			760					•			One valve per bench, 7901, Nelson, 24VAC, 0.5amps, 12W
33				•	M1-	SL-1-2	Service Lighting-1-2	2	120 V	60 W	0.3 A	36 VA	72 VA		•	4500								Switch by door, vapourproof globe lamp with CFL lamp
34				•	M1-	CP-1	Control Panel-1	0.5	120 V	500 W	4.3 A	516 VA	516 VA		•	760								
												SUB-TOTAL:	6387 VA											Each of 4 small compartments

				Corridor (1)																		
35				CO- RVM-W	West Ridge Vent-1 (Open/Close)	2	208 - 3Ph	110 W	0.6 A	288 VA	576 VA	-	-	6000			-		ridder RW-45 - 2RPM			
36		-		CO- RVM-E	East Ridge Vent-1 (Open/Close)	2	208 - 3Ph	110 W	0.6 A	288 VA	576 VA	-	-	6000			-		ridder RW-45 - 2RPM			
37		-		CO- NPF-1	Negative Pressure Fan-2 speed	1	120 V	800 W	7.17 A	860 A	860 VA		-	3500	-				2 sp. motor, DC-30 G-2S-B, acme, 120V, 7.17 A, 800W			
38		-		CO- NPMD-1	Negative Pressure Motorized Damper-1	1	120 V			4 A	4 VA		-	3500		-	-					
39			-	CO- OCP-1	Overhead Circulating pump-1	1	120 V	250 W	2.2 A	260 VA	520 VA		-	-300		-			26-11-6U			
40			-	CO- OCV-1	Overhead Control Valve-1	1	120 V	50 W	0.4 A	48 VA	48 VA		-	-300		-	-					
41		-		CO- CP-1	Control Panel-1	1	120 V	500 W	4.3 A	516 VA	516 VA		-	760								
										SUB-TOTAL:	3099 VA											
				Basement - 2 Lighting Panels. Panel 1 has L1, M1 and M2. Panel 2 has L2, M3 and M4																		
42			-	L1- HPS-1	HPS Lighting fixture 1-48	48	347 V	465 W	1.4 A	488 VA	22486 VA			4300	-				32 lamps, 2.3 amps, 1 control point per each of 5 benches			
43			-	L2- HPS-1	HPS Lighting fixture 1-48	48	347 V	465 W	1.4 A	488 VA	22486 VA			4300	-				32 lamps, 2.3 amps, 1 control point per each of 5 benches			
44			-	M1- HPS-1	HPS Lighting fixture 1-32	32	347 V	465 W	1.4 A	488 VA	14960 VA			4300	-				32 lamps, 2.3 amps, 1 control point per each of 3 benches			
45			-	M2- HPS-1	HPS Lighting fixture 1-32	32	347 V	465 W	1.4 A	488 VA	14960 VA			4300	-				32 lamps, 2.3 amps, 1 control point per each of 3 benches			
46			-	M3- HPS-1	HPS Lighting fixture 1-32	32	347 V	465 W	1.4 A	488 VA	14960 VA			4300	-				32 lamps, 2.3 amps, 1 control point per each of 3 benches			
47			-	M4- HPS-1	HPS Lighting fixture 1-32	32	347 V	465 W	1.4 A	488 VA	14960 VA			4300	-				32 lamps, 2.3 amps, 1 control point per each of 3 benches			
										SUB-TOTAL:	104933 VA											
				SENSORS																		
				New Greenhouse																		
				Compartment (6)																		
48			-	L1- ATDB-1	Air temperature Dry Bulb-1	1											-					
49			-	L1- ATDB-2	Air temperature Dry Bulb-2	1											-					
50			-	L1- AF	Aspirated fan	1	24 V	10 W									-					
51			-	L1- WRVP	West Ridge Vent Position	1											-					
52			-	L1- ERVP	East Ridge Vent Position	1											-					
53			-	L1- WRLS	West Ridge Vent Limit Switches	1									-							
54			-	L1- ERLS	East Ridge Vent Limit Switches	1									-							
				Corridor (1)																		
53		-		CC- ATDB-1	Air temperature Dry Bulb-1	1											-					
54		-		CC- AF-1	Aspirated fan-1	1	24 V	10 W														
55		-		CC- WRVP-1-2	West Ridge Vent Position-1-2	2											-					
56		-		CC- ERVP-1-2	East Ridge Vent Position-1-2	2											-					
57			-	CC- WRLS-1-2	West Ridge Vent Limit Switches-1-2	2									-							
58			-	CC- ERLS-1-2	East Ridge Vent Limit Switches-1-2	2									-							
				Basement (1)																		
59		-		BA- ATDB-1	Air temperature Dry Bulb-1												-		In the basmont			
60		-		BA- ATDB-2	Air temperature Dry Bulb-2												-		doghouse east			
61		-		BA- ATDB-3	Air temperature Dry Bulb-3												-		doghouse west			
				Digital Inputs/Outputs																		
62					Fire alarm input greenhouses																	
63					Emergency power on (input)																	
64					Alarm (output) to security																	
65					Alarm (output) to building DCS																	
				END OF LIST OF POINTS																		

END OF SECTION