

THE **R-HOUSE** by *Rough Brothers Inc.*

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THE R-HOUSE

BY ROUGH BROTHERS, INC.

ALL ALUMINUM GREENHOUSE CONSTRUCTION SYSTEM  
FOR RESEARCH, TEACHING AND EDUCATION APPLICATIONS  
STANDARD SPECIFICATIONS

SECTION 13 34 13.13

PART 1 - GENERAL

PART 2 - PRODUCTS

PART 3 - EXECUTION

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## **Part 1.00     GENERAL**

### **1.01     GENERAL**

- A. It is the intent of this portion of the specifications to include the furnishing and erecting of the greenhouse superstructure including all glazing, doors, door hardware, and ventilation as shown on plans and/or hereinafter described such work to be the responsibility of the Greenhouse Contractor. Greenhouse installation is the responsibility of the greenhouse manufacturer and shall be included with bid on bid day. Material only bids will not be accepted. Bids received after the bid date shall be considered non-responsive and shall not be accepted.
- B. It is not the intent of this portion of the specifications to cover concrete, grouting, masonry work, plumbing, electrical work (power and control wiring), utility connections, final cleaning of glazing, nor counter-flashing. This portion shall be the responsibility of the General Contractor or his selected Subcontractors other than the Greenhouse Contractor.
- C. No masonry or foundation installation shall be made prior to approval of greenhouse drawings. Approved greenhouse drawings shall be used to make all masonry and foundation installations. Dimensions may vary slightly from contract drawings to accommodate manufacturer's standard, but total area shall not be less than 98% of that shown.

### **1.02     SPECIFICATIONS AND PLANS**

- A. These specifications are intended to supplement the drawings and, therefore, it shall not be their purpose to mention any portion of the construction which the drawings are competent to explain and such omissions shall not relieve the Greenhouse Contractor from carrying out such portions indicated only on the drawings and should items be required by specifications which are not indicated on the drawings, they shall be supplied and installed by this Contractor.
- B. Related Work Specified Elsewhere:
  - 1. Concrete floors, grouting of sills and base plates, and masonry walls: Division 03 and 04.
  - 2. Plumbing rough-in work and hook-up of greenhouse plumbing systems, and downspouts described in this section: Division 22.
  - 3. Electrical power wiring, environmental control system wiring, lighting, conduit and hook-ups of greenhouse electrical equipment provided under this section: Division 26.

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**\*NOTE TO SPECIFIER**

The above items need to be addressed specifically in the above named specifications sections and are not covered in this section.

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**1.03 QUALITY ASSURANCE**

- A. The greenhouses shall be erected by the manufacturer or their qualified greenhouse specialty contractor with at least five (5) years experience in building greenhouses of the type specified, similar in size and complexity.
- B. The greenhouse shall be manufactured in accordance with NGMA approved practices. Testing shall be performed in accordance with ASTM standards. Test reports must be certified and submitted by an independent test laboratory. Test reports shall be no more than four years old.
- C. When tested in accordance with ASTM E-283 air infiltration shall not exceed .06 CFM per square foot (.0003 m<sup>3</sup> / s-m<sup>2</sup>) of fixed area, plus .3 CFM per foot of ventilator crack length at 6.24 PSF (75Pa).
- D. When tested in accordance with ASTM E-331, no uncontrolled water penetration at a test pressure of 6.24 PSF.
- E. Structural performance shall be based on: Maximum deflection of 1/175 of span, and allowable stress with a safety factor of 1.65.

**1.04 SUBMITTALS**

- A. Greenhouse Manufacturer shall submit (architects advised quantity) sets of approval drawings.
- B. Approval submittals shall include engineered stamped drawings for the appropriate state, a full set of engineering calculations, and equipment submittal.
- C. Approval drawings shall include the following individual detailed sheets:
  - ◇ Cover Sheet
  - ◇ Floor/ Post Plan
  - ◇ Post Feet Details
  - ◇ Roof Framing Plan
  - ◇ Roof Glazing Plan
  - ◇ Sidewall Elevations
  - ◇ Gable Elevations

- ◇ Partition Elevations (if req'd.)
- ◇ Foundation Plan
- ◇ Equipment Plan
- ◇ Bench Layout (if req'd.)
- ◇ Double Vent Ridge Section
- ◇ Single Vent Ridge Section (if req'd.)
- ◇ Typical Sidewall Section
- ◇ Wall Section @ AeroCool (or gable section)
- ◇ Roof to Gable Section
- ◇ Misc. Closure Details (greenhouse to head house/building)
- ◇ Door & Door Hardware Schedule

## **Part 2.00     PRODUCTS**

### **2.01     MANUFACTURER**

- A. Drawings and specifications are based on ***THE R-HOUSE*** as manufactured by Rough Brothers, 5513 Vine Street, Cincinnati, Ohio 45217, (1-800-543-7351). No substitutes shall be allowed. Manufacturers seeking approval to bid and who have products similar in design and meeting all the requirements of the specifications must submit complete product data and specifications along with a list of seven (7) projects of equal size and magnitude that have been successfully completed and operational for a minimum of four (4) years and evidencing not less than ten (10) years experience in similar work. Name and location of project, name and address of general contractor, name and address of architect shall be provided for each of the references. Further, certification from an independent testing agency documenting that the proposed alternate glazing system has been tested and exceeds air infiltration requirements (per ASTM E-283) and water penetration requirements (per ASTM E-331) must be submitted for Architects and Owner's approval. Only those products received by the architect no later than ten (10) days prior to the bid opening and only those products approved in writing by the architect, prior to the bid opening shall be considered. Any bid from a non-preapproved manufacturer may not be used or accepted.

### **2.02     MATERIALS**

- A. Structure shall be designed and detailed according to good engineering practice. All primary framing shall be 6005 or 6061-T6 and 6063-T6 alloys. All aluminum flashing shall be 5005-H14 alloy. Framing shall consist of clear span aluminum rigid frames on 4'-0" centers spanning the full width of the structure with a (architect specify 3/12 through 12/12) roof pitch. Aluminum shall be mill finish with appropriate heat treatment. No castings, either of aluminum or aluminum alloy, shall be permitted for joining structural members at joints subject to stress in which tensile strength is a factor.

- B. Sidewall columns shall be attached to top of foundation wall or kneewall on slab with epoxy set plated anchor bolts, Grade A36 or A307. Drilling for anchors and setting of plated anchor bolts to be by the greenhouse manufacturer.
- C. Structural connections shall be made with galvanized steel bolts. All bolts 1/4" diameter up to 1/2" diameter shall be A307. All bolts 1/2" diameter or larger shall be Grade 5. Welded connections will not be accepted.
- D. Aluminum members to be mill finish.

### 2.03 STANDARD DESIGN CRITERIA

- A. Standard loads specified below
  - 1. Dead Load - structure and equipment.
  - 2. Live Load - 16 lbs. per sq. ft. on horizontal area.
  - 3. Wind Load - 80 mph, exposure B, per BOCA 1996 National Building Code.
- B. In designing for the above loads, the loads may be considered to act in any of the following combinations:
  - 1. Dead Load plus Wind Load.
  - 2. Dead Load plus Live Load.
  - 3. Dead Load plus Live Load plus Wind Load

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#### \*NOTE TO SPECIFIER

Format for specifying local design load requirement below; include only if standard design loads stated above are not acceptable.

- \* Dead Load - structure and equipment.
  - \* Live Load - (**specify load**) lbs. per sq. ft. on horizontal area.
  - \* Wind Load - (**specify wind speed**) mph, exposure (**specify exposure**) per (**specify code**) building code.
  - \* Snow Load - (**specify load**) lbs. per sq. ft. ground snow per (**specify code**) building code.
- 

- C. In addition to the above, roof bars shall be required to carry a 100 lb. concentrated load at the center of any span.
- D. Structure shall be designed in accordance with current Aluminum Association "Specifications for Aluminum Structures". The maximum allowable deflection

shall be 1/120 of the span. Structure shall include adequate bracing for the lateral support of structural members and framing, and for stability of the structure for the resistance to wind forces. Rigid frame members as well as other members shall be adequate to resist compressive loads produced by horizontal wind loads and roof uplift produced by wind.

#### **2.04 EXPANSION CONTROL**

- A. Suitable expansion joints shall be provided in all longitudinal members to take care of the longitudinal expansion in the aluminum. No longitudinal members shall exceed 21'-0". All members shall be so joined as to require each joint to handle the expansion in the individual member and to prevent an accumulation of expansion in several members in one direction. Allow for a temperature range of 150 degrees F.

#### **2.05 ALUMINUM FRAME**

- A. Rigid frame members and connection plates shall be mill finish aluminum. Welded connections will not be accepted. Special care shall be taken in the fabrication of this aluminum work, and all tolerances shall be held to an absolute minimum in order to secure proper fit of the aluminum members specified. Truss systems will not be acceptable.
- B. Aluminum columns shall be furnished and placed on four foot centers through the length of the greenhouse, and across all partitions and gables as required. Columns shall be punched, or drilled to attach required aluminum members. No joint shall be allowed, either of combined extrusions or a casting that shall be fastened to the flange of the column thereby placing fasteners in tension or twist.
- C. Aluminum rafters shall be furnished and placed in the roof of the greenhouse, extending from the eave or gutter to the ridge. Each pair of rafters shall be connected together at the ridge by means of aluminum plates.
- D. Aluminum purlins in the roof, of the size required (minimum 5" for shade clearance) shall be furnished and connected to supporting members with a minimum of two 3/8" dia. galvanized steel bolts into each member. Purlins shall be prefabricated before shipment for the attachment of glazing bars and purlin clips.
- E. Provide all other structural members, bracing, clips, and fasteners not mentioned above but required to complete the framework of the greenhouse.

#### **2.06 GUTTER**

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\* NOTE TO SPECIFIER

Delete the following paragraph if greenhouse does not include gutter.

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- A. An extruded aluminum gutter, 6" wide x 7 1/2" deep, with extruded drip gutter and internal downspout connections shall be provided where indicated on the drawings. This member shall have a flange to receive glazing bars and shall be provided with weep holes to carry condensation collected from the underside of the roof to the drip gutter. Gutter to include safety foot treads as a safety factor. Gutters without integral extruded safety tread shall not be accepted.
- B. Connections for gutter downspouts shall be provided where indicated on drawings. Final connection and downspout material covered in other section.

## 2.07 EAVE

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\* NOTE TO SPECIFIER

Delete the following paragraph if greenhouse does not include eave.

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- A. An extruded aluminum eave shall be provided where indicated on the drawings. This member shall have a flange to receive glazing bars and shall have a gutter and weeping system to carry condensation collected from the underside of the roof to the outside of the greenhouse. Weep system will be rain screened or baffled to prevent water from entering the system through the weep holes. Weep holes shall be minimum 1/4" dia. 4' - 0" on centers. The eave will include a continuous socket hinge, which will allow the installation of an extruded transition closure to the roof glazing system.

## 2.08 RIDGE

- A. An extruded aluminum ridge shall be furnished and placed at the peak of the structure.

## 2.09 GABLE ENDRAFTER

- A. Specially extruded gable and corner trim assembly shall be provided to enclose roof glazing bar, vertical side and gable glazing and glazing bars. The gable and corner trim shall be neatly mitered and spliced at the ridge and at the eave or gutter to provide a smooth detail at this point. These shall be securely fastened to the structural members, forming the gable end. Sightlines at gable, vertical corners and eave will match. Exposed fasteners at this location are not acceptable.

## 2.10 SIDE AND END WALL GLAZING SYSTEM

- A. System shall include a continuous gutter at each horizontal member. Gutter will direct infiltrated water to the exterior through rain screened weep holes that prevent water from entering. Weeps shall be minimum 1/4" dia. 2' – 0" on centers. Horizontal members shall be constructed to allow for vertical thermal movement within the member without binding or twisting. Gutter shall be spliced to allow for horizontal thermal movement without binding or leakage. Corners of gutter to be shop welded.
- B. Vertical glazing bars shall be attached to the horizontals with integral screw splines or shear blocks and assembled to minimize exposed fasteners.
- C. Bars shall include extruded races for glazing gaskets interior and exterior. Wet seal systems will not be allowed.
- D. Provide snap-on trim for exterior glazing bars to conceal bar bolts.
- E. Glazing system shall be mill finished aluminum.

## **2.11 ROOF GLAZING SYSTEM**

- A. Roof glazing system will incorporate mill finished aluminum bars and caps designed to provide glass capture on all four sides.
- B. Rafters shall extend from eave to ridge in one piece and contain condensation gutters to direct water to the eave weeping system. Intermediate glazing purlins shall have condensation gutters that direct water to the glazing rafters.
- C. The aluminum glazing bars shall be of sufficient size and section modulus to carry the design loads required. Limit deflection of any glass supporting member to L/175 or 1/4" whichever is smaller. Glazing bars shall be attached to the structure with galvanized bolts through factory drilled holes.
- D. Glazing bars shall have integral races to receive glazing gaskets to prevent glass from contacting the bar or bar cap. Wet seal systems will not be allowed.
- E. Roof glazing system shall incorporate a continuous thermal isolator to minimize direct, metal to metal contact between interior and exterior members.
- F. Provide mill finished aluminum snap-on trim for exterior glazing bars to conceal bar bolts.

## **2.12 KNEEWALL/CURB SILL FLASHING**

- A. Aluminum sill flashing shall be placed on the outside of the perimeter kneewall or curb. Sill flashing shall be placed under the glazing sill member and to the outside of the greenhouse columns, covering the top of the exposed kneewall or

curb including any insulation and/or face veneer, if present. Aluminum sill flashing shall extend no less than 2" down the vertical face of the kneewall or curb. Sill flashing at curb, kneewalls, or connection to adjacent structures shall be a minimum 1/16" thick. All sill corner flashing shall be shop welded. All sill flashing and end flashing conditions at door openings shall be shop welded closures matching the profile of the sill flashing. All sill flashing to be laid end to end with a .032 x4" long splice cap matching the profile of the sill flashing. Splice cap to be set in sealant and held in place with pop-rivets. Lapped sill flashing at joints is not acceptable.

## 2.13 ROOF VENTS

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\* NOTE TO SPECIFIER

Delete the following paragraphs below if greenhouse does not include roof vents.

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- A. Automatic 36" ridge vents with a continuous socket hinge shall be furnished and arranged to open out. Vents for any given compartment, when assembled and installed, shall be continuous from one end to the other. Ridge vents shall be made up of a top rail, bottom rail, and mullions of extruded aluminum. They will then be bolted together in accordance with the manufacturer's instruction.
- B. All vents shall have provision made at the hinge point to prevent creeping of the vents.

## 2.14 SIDE VENTS

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\* NOTE TO SPECIFIER

Delete the following paragraphs below if greenhouse does not include side vents.

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- A. Automatic 26" sidewall vents with a continuous socket hinge shall be furnished and arranged to open out. Vents for any given compartment, when assembled and installed, shall be continuous from one end to the other. Side vent shall be made up of a top rail, bottom rail and mullions of extruded aluminum. They will then be bolted together in accordance with manufacturer's instructions.
- B. All vents shall have provision made at the hinge point to prevent creeping of the vents.

## 2.15 VENT OPERATORS

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**\* NOTE TO SPECIFIER**

Delete paragraphs in the following section that do not apply to project.

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- A. All vents shall be operated with aluminum scissor type operators. Rack and pinion systems or elbow arms are not acceptable.
- B. Provide extruded aluminum cover full length of shaft.
- C. Provide 1.315" diameter galvanized drive shaft with aluminum couplings.
- D. Delrin shaft hangers shall be provided to support roof and side vent drive shaft.
- E. Scissor operators will be installed no more than 72" on centers.

**2.16 VENT MACHINES**

- A. Wadsworth, Lock or Ridder vent machines shall be used to operate motorized roof vents.
- B. Wadsworth, Lock or Ridder vent machines shall be used to operate motorized side vents.

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***\*NOTE TO SPECIFIER***

***Do not include the following information in the specifications. For reference use only.***

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<u>MFGR.</u>	<u>MODEL NO.</u>	<u>CAPACITY</u>
Wadsworth	VC100	Roof vents up to 52' long Side vents up to 72' long
Wadsworth	VC2000	Roof vents up to 155' long Side vents up to 155' long
Ridder	RW45-1	Roof vents up to 128' long Side vents up to 153' long
Ridder	RW241	Roof vents up to 256' long Side vents up to 306' long

Lock	EWA60	Roof vents up to 75' long Side vents up to 75' long
Lock	EWA12	Roof vents up to 135' long Side vents up to 135' long

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**\*NOTE TO SPECIFIER**

Thermostats or automatic controls are not included with vent machines, unless specified.

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## 2.17 ROOF & SIDE VENT SCREENS

- A. Screens shall be provided at all vent openings and at evaporative pads. Screen rails shall be 5/16" x 7/8" mill finish extruded aluminum with a groove to receive a vinyl insert to hold 16 x 18 aluminum mesh in place.
- B. Screen frames shall be assembled with die cast aluminum corners and designed to allow for re-screening of units in the field.
- C. Brush seals shall be provided at ends of screen frames where vent operator arms penetrate and will be manufactured and installed in a manner as to allow the removal of the screen and frame allowing for cleaning and replacement without the removal of the vent operators.

## 2.18 DOORS AND FRAMES

- A. Single doors shall be 1 3/4" x 3'0" x 6'8" half panel clear anodized with 5" extruded tube rails and 4" extruded aluminum tube frame with wool pile seals. Hardware shall include (1 1/2 pr.) Hager 4 1/2" x 4 1/2" stainless steel hinges with non removable pins (1) Sargent 28-65G05-KL-26D lever handle lockset with key unlocking outside and push button locking inside, aluminum threshold and door sweep. Upper panel shall be glazed with 1/4" clear safety glazing and lower panel shall be an aluminum faced panel.
- B. Horizontal rail shall be located at midpoint of door height. All rails and frame shall have a .125" minimum wall thickness.
- C. Double doors shall be 1 3/4" x 6'0" x 6'8" half panel clear anodized with 5" extruded tube rails and 4" extruded aluminum tube frame with wool pile seals. Hardware shall include (1 1/2 pr.) Hager 4 1/2" x 4 1/2" stainless steel hinges with non-removable pin per leaf. (1) Sargent 28-65G05-KL-26D lever handle lockset with key unlocking outside and push button locking inside, aluminum threshold and door sweep. Dummy trim and top and bottom concealed flush bolts for

inactive leaf. Upper panels shall be glazed with 1/4" clear safety glazing and lower panels shall be an aluminum faced panel.

- D. Horizontal rail shall be located at midpoint of door height. All rails and frames shall have a .125" minimum wall thickness.

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**\*NOTE TO SPECIFIER**

Where master keying of doors and/or special hardware is required, delete standard hardware from the Greenhouse Specifications and specify in Finish Hardware Section.

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## 2.19 GABLES

- A. Glass gables with fixed gables from sill to gable rafter shall be constructed in a similar manner to the sides using extruded aluminum shapes.

## 2.20 GLAZING

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**\* NOTE TO SPECIFIER**

Based on national, state or local glazing codes for greenhouse use, **specify** the required glazing listed below, and delete the glazing that does not apply.

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### A. Materials

- 1 Roof glass shall be 5/16" clear annealed laminated glass, consisting of two pieces of 1/8" clear heat strengthened float glass and a .060" PVB interlayer. Annealed glass is not acceptable.
  - 2 Side wall glass will be 1" clear insulated units. Insulated glass unit make-up shall be tempered/airspace/tempered. Units shall be hermetically sealed conforming to Sealed Insulating Glass Manufacturers Association No. 65-7-2 "Sealed Insulating Glass Units".
  - 3 Interior partitions shall be glazed with 1/4" clear tempered glass for all typical units. Pieces requiring penetrations or pattern cuts will be 1/4" clear acrylic.
- B. All glass shall be set with extruded glazing gaskets of EPDM or silicone both interior and exterior. The glazing system shall be a pressure plate system with EPDM gaskets and perimeter sealant and all glass shall be set with gaskets interior and exterior on all four sides. Gaskets shall be installed without gaps at the corners. Corners of gaskets to be sealed with silicone sealant.

- C. Aluminum extruded bar caps shall be bolted to the glazing bars with #10 bolts of 18-8 stainless steel. Glazing bar bolts will be installed not more than 2" from each end of the glazing bar and not more than 9" on centers. Glazing bar caps shall have extruded snap covers to conceal glazing bar bolts.

## 2.21 BENCHES

- A. Benches shall be Ro-Flo as manufactured by Rough Brothers. Freestanding, stationary or floating aisle (5'-0" minimum width for floating aisle) benches of the size and quantity shown on the drawings shall be provided. Support system shall be 14 ga.; 1.25" square galvanized steel tubing spaced at 6'-0" intervals. Bench tops shall include 18 ga., 1" square galvanized steel tubing crosspieces spaced at 18" intervals, extruded aluminum side and end rails with (**specify:** 1", 2" or 4") perimeter edge and 3/4" hex #13 hot dip galvanized expanded metal. Safety plastic corner connectors shall be used at end rails on all bench top corners. Exposed metal corners are not acceptable. Two runs of 14 ga., 1.315 o.d. galvanized steel tubing shall be provided to support bench tops above the support system. Two runs of 14 ga., 1.315" o.d. galvanized steel tubing shall be installed 1'-2" above the floor to stabilize the support system). Extruded aluminum fittings with galvanized bolts and stainless steel screws shall be used to assemble the benches. Bench height shall be 2'-6" from floor to expanded metal. Bench support system for floating aisle benches shall be attached to concrete floor with wedge anchor.

## 2.22 VENTILATION AND COOLING

### A. EXHAUST FANS

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\* NOTE TO SPECIFIER

Delete paragraph one (1) or two (2) in the following section to specify the fan required.

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1. Exhaust fans shall be heavy-duty construction, consisting of a cast aluminum propeller having three (3) or more Macheta<sup>®</sup> tip blades, and a formed fiberglass housing and exhaust cone, both having a smooth, gel coat exterior surface. High efficiency, totally enclosed air over (TEAO) motors shall drive fans with heavy duty pulleys and aramid fiber v-belts. Fans are to use a spring-loaded, automotive style v-belt tensioner. Fans shall be protected against rust and corrosion with stainless steel hardware, sealed bearings, and aluminum struts. Fans used in this specification shall be performance certified by an independent testing facility such as BESS

Labs (University of Illinois) and shall list the appropriate test number on the fan. Gravity operated, airfoil style PVC shutters or counter-balanced shutters with aluminum blades shall be provided as part of each exhaust fan. Fans shall be single or two speed as scheduled on the drawings. Fans, wall housings, guards and shutters shall be as manufactured and provided by Aerotech, A Munters Company (Mason, MI).

2. Exhaust fans are to be of galvanized steel or fiberglass construction. Motors, single or three phase, shall be totally enclosed air over (TEAO), shall be thermally protected, and have totally sealed ball bearings. Motors will drive either three (3) or six (6) wing blades via heavy duty pulleys and Gates Tri-Power® molded notch belts with special Vextra® construction. Fans shall include heavy-duty compression spring belt tensioners. Blade construction shall be of “stamped galvanized with embossed spider” or of stainless steel. Galvanized housings shall be eighteen (18) gauge sheet steel. Venturis shall be fourteen (14) gauge spun galvanized steel. Fiberglass housings shall have a uniform thickness of 4.763 mm and have a smooth gel coated exterior and interior. Fans shall have test data from an independent testing facility such as BESS Labs (University of Illinois at Urbana-Champaign). Inlet and outlet guards shall be OSHA approved. Shutters shall be constructed of heavy-duty brushed and anodized aluminum. Shutters shall be counter balanced, and gravity operated. Exhaust fans shall be manufactured and provided by Schaefer Ventilation Equipment (Sauk Rapids, MN).

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## B. EVAPORATIVE COOLING SYSTEM

The wet pad system shall consist of Munters CELdek® evaporative cooling pad specially designed with a cross fluted configuration of cellulose paper impregnated with insoluble anti-rot salts and stiffening agents. The water distributor shall consist of extruded aluminum sections and water deflectors with a rigid, 1½” PVC pipe having metered outlet holes. The collection trough and water deflectors shall be (**specify:** aluminum or self-contained PVC). PVC end panels shall enclose the pads at the ends of all systems. Cooling system shall be AeroCool® as manufactured by Aerotech, (Mason, MI).

1. Furnish and install standard plumbing package which includes float valve, strainer, union, ball valve and piping between pump and water distributor as manufactured by Aerotech, (Mason, MI).
2. A (submersible) pump of heavy duty construction featuring high volume at relatively low head pressure shall be provided for each compartment and installed with a union in the discharge line for easy servicing. The pump shall be supplied by Aerotech, (Mason, MI).

3. The self-contained PVC system shall include a containment sump utilizing a 15" PVC tank connected to the collection trough as manufactured by Aerotech, (Mason, MI). The aluminum collection trough system shall have a water tank with drain plug and cover.
4. Furnish and install necessary aluminum extruded 2 x 4 tube stringers and 0.032" aluminum flashing to prevent air leaks around cooling system.

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**\*NOTE TO SPECIFIER**

Drainage should be provided for evaporative cooling bleed off discharge.

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## **2.23 HIGH PRESSURE HUMIDIFICATION SYSTEM**

### **A. FOG NOZZLES:**

Impaction pin nozzles. Type 316 stainless steel body with 150 micron orifice and type 304 stainless steel impaction pin. Generating droplets of 17 micron (measured as Mass Median Diameter) at operating pressure of 1000 PSI with integral filter (40 micron particle size) and fitting into nozzle adapters with o-ring seal (for hand-tight installation).

### **B. FOG PUMP UNITS:**

Complete fog pump units (refer to schedule for sizes, flow rates and power consumption). Including:

1. Ceramic plunger pumps with Bronze Heads; operating at not more than 900 rpm.
2. Pressure regulating valves; bronze construction with stainless steel valve and valve seat.
3. Pump and motor base; belt drive with full guard to protect operator, epoxy painted steel construction with rubber mounting feet.
4. Electric motor; totally enclosed, fan cooled.
5. Pump Unit must be capable of operating minimum zone without overheating pump head.

6. Low pressure cut-off switch; to protect pump in the event of low inlet pressure, manual reset with signal to HVAC building control computer to alert operator of low inlet pressure condition.
7. Temperature actuated drain valve; to protect pump in the event of too few nozzles being operated at one time.
8. Low pressure gauge; liquid filled, 0-60 psi.
9. High pressure gauge; Liquid filled, 0-2000 psi.
10. Fittings and hoses; low pressure side fittings of brass, high pressure side fittings of 304 stainless steel, low pressure inlet hose, high pressure discharge hose.

#### C. WATER TREATMENT SYSTEMS:

1. Manufacturer to conduct complete water analysis and make recommendation for water treatment, prior to commencing work.
2. Water treatment systems must protect against:
  - a. excessive plugging of nozzles; not more than 10% per year,
  - b. any water condition that could cause excessive wear or damage to the fog nozzles,
  - c. Any dangerous bacteria growth or any condition that could result in dangerous bacteria growth and,
    - a. any possibility of "hazing" of the supply air with mineral salts.

#### D. FOG NOZZLE MANIFOLDS AND MAIN FEED LINES:

1. All nozzle manifold and mainlines shall be 316 stainless steel tube (ASTM A 269, 1/2" outside diameter, 0.035" thick, welded wall).
2. All fittings shall be double-ferrule type compression fittings of type 316 stainless steel tube.
3. Provide insulation for all lines where condensation could form.
4. Provide insulation and heat-tape for all lines where freezing conditions could occur.

#### E. AUTOMATIC CONTROLS:

1. Solenoid valves; brass construction rated for 1200 psi operating pressure and stainless steel valve plunger and seats.
2. Electrical Control Panel; Including;
3. Combination type magnetic motor starter with thermal over-load protection, circuit breaker and main disconnect switch, low pressure cut-off switch relay and reset switch with interface to controller,
4. relays and on-off-auto switches for each solenoid valve with interface to controller, relay for inlet solenoid valve.

F. Manufacturer: MEE Industries, or equal.

## 2.24 HORIZONTAL AIR FLOW FANS

- A. Air distribution system shall be 16" diameter horizontal air flow fans. Assembled unit to include totally enclosed fan cooled motor (115V, 1/15 H.P., 1500 RPM), polyvinyl coated guard, aluminum 3 wind fan blade, 1215 CFM rating and aluminum mounting bracket for hanging.

## 2.25 HEATING

### A. GAS FIRED UNIT HEATERS

1. Gas fired unit heaters shall be provided where indicated on the drawings. Heaters shall be high efficiency gas-fired (**specify:** natural gas *or* propane) horizontal propeller type units. Heaters shall be mounted from the greenhouse structure with the proper hangers. Supply piping and final connection by others. Heat exchanger shall be tubular bent tube design. Heat exchanger tubes and burner shall be stainless steel. Unit heater cabinet shall be stainless steel. A balanced broad blade fan shall be direct driven by an open drip proof motor selected to match the fan requirements. Units shall be equipped with combination solenoid, safety pilot, pressure regulator and manual shut off valve and intermittent-duty elective pilot ignition system with non-lockout. Units shall carry the American Gas Association (AGA) certification for safety or CSA Certification. Installation shall include stack with proper saddles or other accessories for a weather tight penetration of the greenhouse skin, and weather cap. Unit heaters shall be as manufactured by Sterling or Delta – T solutions.

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**\*NOTE TO SPECIFIER**

If unit heaters are to be propane gas specify intermittent duty electric pilot ignition with lockout, stainless steel primary heat exchanger, and burner.

If unit heaters are not to be used delete above section.

If a hot water fin-tube heat is not to be used, delete the below section.

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**B. FIN-TUBE HOT WATER HEATING SYSTEM**

1. General Requirements: The heating system for the greenhouse shall be a Delta-T Hot Water Heating System. The system is designed under the following conditions:
  - a. Inside Temperature: 70 deg F
  - b. Outside Temperature: -10 deg F
  - c. Temperature Difference: 80 deg F
  - d. Hot Water Supply: 180 deg F
  - e. Hot Water Return: 160 deg F
  - f. Relief Valve Pressure: 60 psi
  - g. Operating Pressure: 12 psi

General system requirements: The system shall consist of (enter # zones) perimeter heating zones. Perimeter heat pipes shall be positioned “low” in (enter # research zones) research areas and “high” in (specify corridors, work rooms, display areas, etc. if applicable).

2. Heating Source: The heat source that will be supplying the water to the radiating materials: (choose one)
  - a. Supplied by others with the required flow being supplied as per the design drawing.
  - b. Shall be a natural gas fired boiler (see specification)
  - c. Shall be oil fired boiler (see specification)
  - d. Shall be a steam to hot water generation package (see specification)
3. System Pumps: The pumps shall be centrifugal pumps
  - a. Federal in line-
    - i. Casing – Standard pumps are built with the suction connection 180° from the discharge connection. Casings can be field rotated for a 90° position changes. Suction and discharge connections are standard ASA Flanges. Top pull-out design permits removal of the rotating assembly without disconnection

the suction or discharge piping. Centerline discharge permits straight through piping.

- ii. Impeller – single-piece enclosed bronze balanced impellers, with diameters cut for specified condition points.
  - iii. Shaft – The pump end is mounted directly on the motor shaft, eliminating alignment problems. A bronze shaft sleeve prevents contact between the shaft and the liquid being pumped.
  - iv. Mechanical Shaft seal – A leak-less mechanical shaft seal is standard on all models with the ceramic and carbon faces and stainless steel metal parts. A copper by-pass flushes the seal chamber to prevent dead-ending of abrasives.
  - v. Motors – Pumps are built with totally enclosed fan cooled motors. Fractional horsepower single-phase motors have built-in overload protection. All motors must have motor starters supplied by others.
- b. Grundfos Inline
- vi. The pump shall be of the in-line, single-stage design with close-coupled motor. The pump models shall be furnished as shown on the plans and installed in accordance with the manufacturer's recommendations. The pump shall be capable of delivering \_\_\_\_\_ gallons per minute (\_\_\_\_\_ cubic meters per hour) when operating at a total developed head of \_\_\_\_\_ feet (\_\_\_\_\_ meters). The pump shall be capable of operating continuously at temperatures from 5°F to 288°F (-15°C to 140°C) and working pressures of 145 psi (10 Bars).
  - vii. The pump housing, motor stool, and shaft coupling shall be constructed of close-grained cast iron. For open systems the pump housing and motor stool are available in bronze.
  - viii. The impeller, impeller seal ring, and pump shaft shall be constructed of stainless steel. The impeller shall be secured to the pump shaft by means of stainless steel split cone and nut. The pump shall be equipped with a high temperature bellows seal assembly with Tungsten Carbide/Carbon seal faces mounted in stainless steel components.
  - ix. Motor: The pump motor shall be sized to ensure the pump is non-overloading when operating on the specified pump curve. The motor shall be of the horsepower, voltage, phase and cycle as shown on the drawings. Motor design shall be:
    1. Open Drip Proof
    2. Totally Enclosed Fan Cooled
    3. Grundfos MLE, integrated variable frequency drive, PI control, T.E.F.C. (IP55), 95% relative humidity rating, infra-red communication to R100 (infra-red, 3 phase only)
    4. Explosion Proof
    5. Wash Down

6. Chemical Duty
  7. Other (specify)
    - With a NEMA C face design operating at a nominal \_\_\_\_\_RPM with a minimum service factor of 1.15 (single phase, integrated variable frequency motor, 1.0 service factor). Lower motor bearings shall be adequately sized to ensure ong motor life.
  - x. Furnish Grundfos VersaFlo TP circulators.
4. Zone Control: By-pass zone control shall be able to supply water to the zone or pass water flow from the main system pump while maintaining a constant designed flow rate using an automatic flow control and three-way control valve. Control of the actuated valve shall be a 24v-3 wire floating control from a:
- a. Control Valves: Three-way control valves shall be manufactured by Honeywell. Valve actuator shall be removable and be connected to 24V power to open and power to close control. Valve shall be bronze construction up to 2.0” with removable internal parts without removing the valve from the piping, EPMD O-ring and stainless steel stem. Valves provided by and installed by greenhouse contractor.
  - b. Automatic flow controls shall be manufactured by AutoFlow factory set to automatically limit the flow within 5% of specified amount. Internal wear surfaces of the valve cartridge are nickel and stainless steel with stainless steel spring.
5. Radiation shall supply total heat loss based on the design criteria using the following materials:
- a. Radiation Fin Tube: Radiating materials shall be the Delta-T Fin SF125 aluminum finned pipe, using water temperatures up to 230°F and will consist of the following components: 1.25” schedule 40 aluminum pipe with 3.25”x3.25”x0.025” aluminum fins with a minimum of 48 fins/foot. Pipe shall have each end grooved to accept the grooved coupling provided. Coupling shall be grooved style with high temperature gasket rated for -60°F to 230°F. Coupling and external grooved fin system shall absorb expansion from heated aluminum. Pressure ratings of 125 psi at 230°F.
6. Expanded metal mesh fin tube covers to be provided over the Fin Tube heating system in compartments with “low” perimeter fin position.
7. Environmental Controller: Controller will control the actuator based on air temperature.

8. Design: The heating system design shall meet uniform mechanical code, shall be blue lined drawings on standard D size, Stamped by mechanical engineer.
9. Installation: Full installation of the above system will be responsibility of the greenhouse contractor. The installation shall be done with a crew with not less than 3 years of hot water heating systems installation experience. All necessary elbows, nipples, drain plugs, air bleeders, expansion joints, etc.; to complete the system should be included in the system.

## 2.26 ENVIRONMENTAL CONTROL SYSTEM

- A. Provide and mount an environmental controller, stand alone microprocessor based on greenhouse environmental control panel that includes the following items: complete low voltage operation (24 VAC); internal time clock; a minimum of eight programmable analog greenhouse sensor inputs; a minimum of four programmable digital override inputs; a minimum of four programmable ventilation control outputs; a minimum of four active and maintained cooling outputs; and two active and maintained heating outputs. To have up to four modes of day, (Day, Mid, Eve, Night) for all set points of the greenhouse equipment. The system shall have a minimum of two line LCD display for system operation functions and programming; and three front panel located, momentary toggle switches for complete system programming, and an internal RS-485 interface for connection to computer system. The system must have the capacity to allow remote control for all set points, differentials and data logging via remote modem connection. The Procom environmental controller shall be by MicroGrow Control Systems.
- B. Provide and mount an ETL, UL, CA listed greenhouse controller and a pre-wired NEMA contactor cabinet for control of heating, ventilation, and cooling systems noted on drawings. The contactor panel shall contain relays and/or magnetic contactors for control of the equipment. Control and power wiring and conduit by electrical contractor.
- C. Provide indoor temperature and relative humidity sensor for each controlled zone. Installation and control wiring by electrical contractor.
- D. Provide and mount an outside weather station, Weathermaster, to monitor wind direction / speed, temperature, precipitation, and solar connect to the environmental control system for vent override and heating control and weather station control panel. Control wiring by electrical contractor.
- E. Provide and mount an alarm dialer with two channels for four programmable phone numbers per channel. Any sensors that are wired to the Procom Controller

can be used to trigger the alarm. Dedicated phone line to be provided and installed by others. Control wiring by electrical contractor.

- F. Provide and install Growlink software program complete with custom screen settings for each controlled zone. Accessible remotely from a PC to monitor entire greenhouse operations and generates color graphs or spreadsheets of the sensor readings and equipment positions. This collected data can also be exported to other programs such as Excel. The Growlink system works with any version of Microsoft Windows®. Computer to be provided by others.
- G. Operations: All aspects of the environmental control system will be programmed and operated locally from individual control panels as complete stand-alone units without the need of the main computer, including:
  - 1. Greenhouse passive cooling: Operation of greenhouse roof vents by means of timed pulsing drive open, drive close. The control system must allow for incremental roof vent operation in no less than eight in incremental stages. Adjustable delays, differentials, and separations. Adjustable temperature ramp times.
  - 2. Active Greenhouse Cooling: Programmable stages of maintained cooling to operate exhaust fans, evaporative cooling pads and other connected cooling equipment.
  - 3. Greenhouse Heating: Programmable stages of maintained heating to operate hot water heating system. Pulsing in up to eight stages. Solar influence of set points to raise and lower temperatures automatically based on solar levels.
  - 4. Greenhouse Shading Operations: Programmable stages of open/close based on time of day and/or temperature.
  - 5. Greenhouse Crop Lighting: By means of solar radiation and/or time of day with adjustable delays, differentials and separations.
  - 6. Greenhouse Alarm Functions: By means of adjustable set points for all connected sensors.
  - 7. Data Collections Ability to collect and monitor data for each compartment individually using Microsoft Windows based software.
- H. Testing and Owner Training: Allow two day on-site for testing and owner training by environmental controls manufacturer.
- I. NOTE: In addition to the electrical line voltage equipment wiring requirements, low voltage conduits and wiring will also be required for a complete operational

greenhouse system. This work and the associated materials are not performed or provided by Rough Brothers. This work would include, but not be limited to:

- 1 The limit switch cables routed from each vent or shade motor back to each individual reversing control box.
- 2 All hot water valves, all heaters, all steam valves.
- 3 All sensor conduits, indoors and outdoors including the mounting of the actual sensors.
- 4 All interconnection control cable shown on the Micro Grow drawings.
- 5 Any added low voltage equipment such as shutters, VFD control lines, starter lines, etc. not mentioned here.

## 2.27 RETRACTABLE SHADE/HEAT RETENTION CURTAIN SYSTEM

### A. GENERAL

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\* NOTE TO SPECIFIER

**Specify** number of independently operating systems along with size of greenhouse.

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1. Independently motorized Shading, Cooling and Heat Retention Curtain System(s) designed for size as shown on the drawings as manufactured by Rough Brothers Inc.
2. Curtains are to travel simultaneously from truss to truss and have a peaked or "roofline" profile with a flat top.
3. Curtains are to be suspended from U.V. stabilized reinforcing tape and suspension hooks which slide on stainless steel wires.
4. All curtains are to come sewn to size complete with reinforcing tape and suspension hooks factory installed.
5. Curtain fabric to be (**specify fabric listed below**).

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**\* NOTE TO SPECIFIER**

\* **Specify** one of the following curtain fabrics:

X.L.S. 14	Polyester & Aluminum	45% shade factor	52% energy savings (XLS14F:20)
X.L.S. 15	Polyester & Aluminum	50% shade factor	57% energy savings (XLS15F:20)
X.L.S. 16	Polyester & Aluminum	65% shade factor.	62% energy savings (XLS16F:25)
X.L.S. 17	Polyester & Aluminum	75% shade factor.	67% energy savings (XLS17F:30)
X.L.S.	OBSURA A & B aluminized blackout fabric	99% shade factor	75% energy savings

\* All of the fabrics above are available in a flame retardant version, known as REVOLUX.

\* The fabrics above, excluding the blackout fabric, are available in an open structure when shading only is required. Ventilation through the shade, (when in the closed position), is possible, however energy savings are compromised, (see energy savings values).

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**B. MOTORS AND CONTROLS**

1. System to be independently operated by one motor.
2. Motor is to be U.L. or CSA approved.
3. Gearboxes are to use double worm gears for longer life and quieter operation.
4. Primary and backup limit switches for each travel direction can be integrally mounted into the motor.
5. Control panel is to be prewired for computer hookup, equipped with a manual override switch.

**C. DRIVE SYSTEM**

1. Drive cables to be stainless steel.
2. Cable drums to be of UV stabilized material and manufactured with grooves for cable separation for longer cable life.
3. Cable drums to have 2-3/4" minimum diameter and hold 18 feet of cable.
4. Driveline is to contain one driveline drum per drive cable which provides simple adjustment if required.
5. Cable return pulleys to be of UV stabilized material and have sealed bearings.

#### D. SYSTEM HARDWARE

1. All suspension wires to be bright polished 2mm stainless steel.
2. All hardware is to be corrosion protected by either galvanizing or plating.

### 2.28 LIGHTING

#### A. HIGH PRESSURE SODIUM FIXTURES (HPS)

High Pressure Sodium fixtures shall have the following characteristics:

1. Fixture:  
Complete extruded aluminum enclosure housing the ballast, capacitor and igniter. The two aluminum pieces for the sides of the fixture body shall have vents helping to prolong the life expectancy of the internal components. Assembly and parts shall be UL/CSA approved. 60 Hz ballast designed to withstand greenhouse operating conditions.
2. Reflector:  
Shall be made of one piece of 99% aluminum, polished and anodized, sealed with a silicon (silicium) finish. The type of reflector to be used shall be according to the calculation provided.
3. Bulb:  
High Pressure Sodium bulb CSA/UL approved, initial output and life expectancy will be provided according the manufactures specifications. Acceptable brands Philips and Osram.
4. Mounting Hardware:  
The use of aluminum or steel track will vary depending on the project. Necessary mounting hardware shall be provided with the calculation and drawing. Light fixtures shall be as manufactured by P.L Light Systems Canada

#### Remote Units

5. Fixture:  
Complete extruded aluminum enclosure housing the ballast, capacitor and igniter. The two aluminum pieces for the sides of the fixture body shall have vents helping to prolong the life expectancy of the internal components. The body will be separated from the reflector by a 12' cord with a standard plug on it providing the possibility of different positions for the reflector and the house at the installation time. Assembly and parts

shall be UL/CSA approved. 60 Hz ballast designed to withstand greenhouse operating conditions.

6. Reflector:

Shall be made of one piece of 99% aluminum, polished and anodized, sealed with a silicon (silicium) finish. The type of reflector to be used shall be according to the calculation provided. On this case the reflector shall not be attached to the housing.

7. Bulb:

High Pressure Sodium bulb CSA/UL approved, initial output and life expectancy will be provided according the manufactures specifications. Acceptable brands Philips and Osram.

8. Mounting Hardware:

The use of steel wires or steel track will vary depending on the project. Special clips will be provided for proper mounting according to the final lay-out. Light fixtures shall be as manufactured by P.L Light Systems Canada

## B. METAL HALIDE FIXTURES (MH)

Metal Halide fixtures shall have the following characteristics:

9. Fixture.

Complete extruded aluminum enclosure housing the ballast, capacitor. The two aluminum pieces for the sides of the fixture body shall have vents helping to prolong the life expectancy of the internal components. Assembly and parts shall be UL/CSA approved. 60 Hz ballast designed to withstand greenhouse operating conditions.

10. Reflector.

Shall be made of one piece of 99% aluminum, polished and anodized, sealed with a silicon (silicium) finish. A glass plate will be provided with these reflectors as well. The type of reflector to be used shall be according to the calculation provided.

11. Bulb.

Metal Halide bulb CSA/UL approved, initial output and life expectancy will be provided according to the manufactures specifications. 60 Hz ballast designed to withstand greenhouse operation conditions .Acceptable brands Philips and Osram.

12. Mounting Hardware.

The use of aluminum or steel track will vary depending on the project. Necessary mounting hardware shall be provided with the calculation and drawing. Light fixtures shall be as manufactured by P.L Light Systems Canada

### Remote Units

#### 13. Fixture.

Complete extruded aluminum enclosure housing the ballast, capacitor. The two aluminum pieces for the sides of the fixture body shall have vents helping to prolong the life expectancy of the internal components. The body will be separated from the reflector by a 12' cord with a standard plug on it providing the possibility of different positions for the reflector and the house at the installation time. Assembly and parts shall be UL/CSA approved. 60 Hz ballast designed to withstand greenhouse operating conditions.

#### 14. Reflector.

Shall be made of one piece of 99% aluminum, polished and anodized, sealed with a silicon (silicium) finish. A glass plate will be provided with these reflectors as well. The type of reflector to be used shall be according to the calculation provided. On this case the reflector shall not be attached to the housing.

#### 15. Bulb.

Metal Halide bulb CSA/UL approved, initial output and life expectancy will be provided according the manufactures specifications. Acceptable brands Philips and Osram.

#### 16. Mounting Hardware.

The use of steel wires or steel track will vary depending on the project. Special clips will be provided for proper mounting according to the final lay-out. Light fixtures shall be as manufactured by P.L Light Systems Canada

## **2.29 LOW PRESSURE BENCH MOUNT IRRIGATION SYSTEM**

### **A. OVERHEAD MISTING UNITS:**

The main line water supply system should maintain no greater than 50psi. If the existing system does maintain a higher pressure than 50psi a regulator to be supplied and installed by others will be required.

1. Install 25mm aluminum PolyRail extrusion, supported by an aluminum riser system that is equivalent to mist pattern coverage on bench, complete with connectors, hangers, riser stands, polypipe and punch tool.
2. Aluminum 24" or 36" riser posts are to be mounted to the top of bench at 12' intervals with appropriate aluminum base and cap with hook.
3. Flexible hose assemble will consist of 3/4" diameter X 6' long water supply hose with 3/4" fht swivel couplings at each end. The flexible hose will connect the bench top polypipe to the ball valve and will mount to the end of the bench with a 3/4" clamp.
4. Each bench will be equipped with a 3/4" 24vac Professional series fast acting Solenoid valve, and 3/4" single union ball valve. The ball valve is to connect to the solenoid valve.

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\* NOTE TO SPECIFIER

**Item – #5:** can be deleted if irrigation water source has been filtered to 100 micron by a central filtration system.

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5. Greenhouse manufacturer will supply a 1" cartridge filter 100 micron with 150 screen mesh that is rated for 25gpm for multiple benches (*not to exceed the recommended filter flow rate*), installation by others.
6. Nozzles will be alternating Blue and White JetRain with low pressure ADV at 3' on center
7. The water source and distribution piping to the solenoid valve for each bench is by others.

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\* NOTE TO SPECIFIER

**Section - B. AUTOMATED CONTROLS:** Are a standalone system for irrigation control, but can be deleted if the environmental control system is designed to control the irrigation system.

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**B. AUTOMATIC CONTROLS:**

1. Solenoid valves; Fast acting performance, Globe type Body and cover to be nylon reinforced construction rated for 10-150psi operating pressure (ANSI: Class 125) and stainless steel valve plunger and seats.

2. Misting Control Panel; Including;

- on-time misting 1-250 seconds
- Minimum cycle time 1 till 250 minutes
- Maximum cycle time 1 till 250 minutes
- Temperature input
- Misting valves starting on time or temperature
- Automatically adjustment of the misting cycle by the temperature.
- Pump output option
- 115vac

C. Manufacturer: DRAMM Corporation, or equal.

## **Part 3.00     EXECUTION**

### **3.01     INSTALLATION**

- A. Drilling and setting of anchor bolts is to be by greenhouse manufacturer.
- B. Install entire system and all components in strict accord with manufactures recommendations.

### **3.02     DISSIMILAR MATERIALS**

- A. Separate dissimilar metals with polyurethane or asphaltic coating. Separate aluminum from cementitious material with polyurethane or asphaltic coating.

### **3.03     GROUTING**

- A. After the Greenhouse Contractor has placed the wall sills, the Masonry Contractor shall provide the necessary materials and labor to grout between the wall and the sill to eliminate any discrepancies between the two and produce a finished joint.

### **3.04     FLASHING**

- A. All counter-flashing shall be furnished and placed by the sheet metal contractor. Drawings establishing flashing line shall be furnished by the Greenhouse Contractor. All flashing and counter-flashing shall be aluminum.
- B. Sill flashing is required. Provide mill finished aluminum flashing with a minimum thickness of .060". Sill flashing should have no penetrations in the horizontal leg. Sill flashing to be set in sealant. Extruded sills, which rely on one bead of caulking to prevent water infiltration at the sill will be set on flashing.

### **3.05 INSTRUCTION**

- A. Greenhouse Manufacturer's project manager shall be certified for having completed an OSHA Construction Safety Training Course, ten (10) hour minimum. Greenhouse Manufacturer shall provide to the jobsite one (1) complete "job-specific" Jobsite Safety Manual.
- B. In addition to a minimum of (1) site visit by greenhouse manufacturer project management, greenhouse manufacturer shall instruct owner on use of greenhouse and systems. Provide operation and maintenance manuals to owner.
- C. Greenhouse Manufacturer shall supply the project with complete sets of Operation & Maintenance manuals both in three ring binders (4) and in CD format. Maintenance manuals shall include all equipment data and product literature including all periodic maintenance requirements.

### **3.06 WARRANTY**

- A. Greenhouse Manufacturer shall provide a one (1) year warranty on materials and workmanship from date of substantial completion.