

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

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**THE R-HOUSE**

**BY ROUGH BROTHERS, INC.**

**ALL ALUMINUM GREENHOUSE CONSTRUCTION**

**STANDARD SPECIFICATIONS**

SECTION 13 34 13.13

PART 1 - GENERAL

PART 2 - PRODUCTS

PART 3 – EXECUTION

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## **PART 1 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 (if required), and ventilation as shown on plans and/or hereinafter described such work to be the responsibility of the Greenhouse Manufacturer. 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 Manufacturer.
- 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 Manufacturer 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.
- 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 six (6) sets of approval drawings.
- B. Approval submittals shall include engineered stamped drawings for the appropriate state, a full set of engineering calculations, equipment submittal and a full warranty per Paragraph 3.06 of this specification.
- C. Approval drawings shall include the following detailed information:
  - ◇ Cover Sheet
  - ◇ Floor/ Post Plan
  - ◇ Post Feet Details
  - ◇ Roof Framing Plan
  - ◇ Roof Glazing Plan
  - ◇ Sidewall Elevations
  - ◇ Gable Elevations
  - ◇ Partition Elevations (if req'd.)
  - ◇ Aluminum Truss (or Rigid Frame Sections)
  - ◇ Foundation Outline & Greenhouse Structural Loads
  - ◇ Equipment Plan & Section with Electrical Loads
  - ◇ Bench Layout & Irrigation Plan (if req'd.)
  - ◇ Heating Plan & Details (if req'd)

- ◇ Plant Lighting Plan including Light Rack Plan & Details (if, req'd)
- ◇ Double Vent Ridge Section
- ◇ Single Vent Ridge Section (if req'd.)
- ◇ Typical Wall Section
- ◇ Roof to Gable Section
- ◇ Misc. Closure Details (greenhouse to head house/building)
- ◇ Door & Door Hardware Schedule

## **PART 2 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. All specified equipment manufacturers/models here in named shall be provided. If substitute equipment manufacturers/models are to be used, it shall be so indicated at time of bid and bidder shall offer an alternate deduct for the substitution(s) and obtain prior approval from the owner and architect. Any bid from a non-preapproved manufacturer or a bid containing non-preapproved equipment manufacturers/models may not be used or accepted.

### **2.02 MATERIALS**

- A. Structure shall be designed and detailed according to good engineering practice by a structural engineer licensed in the State of the project. 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 and /or Magni coated 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 factory 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 and/or Magni coated 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 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.

## 2.10 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.

## 2.11 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

## **2.12 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.

## **2.13 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.

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\* NOTE TO SPECIFIER

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

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## 2.14 ROOF VENTS

- 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.

## 2.15 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.

## 2.16 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. Sidewall vents shall be operated with aluminum scissor type operators. Rack and pinion systems or elbow arms are only acceptable for the ridge vents.
- 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.

## 2.17 VENT MACHINES

- A. Lock EWA-10 and/or EWA-12 vent machines shall be used to operate motorized ridge vents and sidewall vents. Vent machine to have line voltage limits.

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### \*NOTE TO SPECIFIER

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

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## 2.18 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.

## 2.19 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 laminated glass, consisting of two pieces of 1/8" clear heat strengthened float glass and a .060" PVB interlayer.
  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.

## 2.20 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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## 2.21 ALUMINUM BENCHES

- A. Aluminum 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 1.25" square aluminum tubing with rounded corners and a .125" wall thickness spaced at 6'-0" intervals maximum (galvanized steel supports, legs or bench tops are not acceptable). Bench tops shall be 1" x 1" x .125" square aluminum tubing crosspieces spaced at 18" intervals, extruded aluminum side and end rails with 1" perimeter edge and 3/4" x .081H aluminum 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 1.315" o.d. aluminum tubing with a .125" wall thickness shall be provided to support bench tops above the support system. Two runs of 1.315" o.d. aluminum with a .125" wall thickness shall be installed 1'-2" above the floor to stabilize the support system. Extruded aluminum fittings with all stainless steel screws and fasteners (galvanized screws or fasteners are not acceptable). Aluminum bench height shall be 2'-6" from floor to expanded aluminum bench top metal. Aluminum bench support system for floating aisle benches shall be attached to concrete floor with wedge anchors. (Galvanized steel benching systems are not acceptable).

## 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. Motorized, airfoil style PVC shutters or shutters with aluminum blades shall be provided as part of each exhaust fan. Shutter motor kits to include drive motor, crank arm, pull chain, return spring and hardware. Fans shall be single or two speed as scheduled on the drawings. Fans, wall housings, guards, shutters and shutter motor kits 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). © 2007 Copyrighted Property of Schaefer Ventilation Equipment

## B. EVAPORATIVE COOLING SYSTEM

1. 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).
2. 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).
3. Furnish and install bleed off valve and tube. Tube to be taken to nearby drain, drain by others.
4. 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).
5. 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.

6. Furnish and install aluminum extruded 2 x 4 tube stringers and 0.032" aluminum flashing to prevent air leaks around cooling system.

**C. LOW LEAK INSULATED DAMPER**

1. Automatic motorized low leak insulated dampers to be provided to the exterior of the evaporative cooling pad system. Dampers are to be operated by Belimo actuators. Dampers are to be provided by EAP, Inc.

**2.23 HIGH PRESSURE HUMIDIFICATION SYSTEM**

**A. FOG NOZZLES:**

1. 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:**

1. Complete fog pump units (refer to schedule for sizes, flow rates and power consumption). Including:
  - a. Ceramic plunger pumps with Bronze Heads; operating at not more than 900 rpm.
  - b. Pressure regulating valves; bronze construction with stainless steel valve and valve seat.
  - c. Pump and motor base; belt drive with full guard to protect operator, epoxy painted steel construction with rubber mounting feet, electric motor; totally enclosed, fan cooled.
  - d. Pump Unit must be capable of operating minimum zone without overheating pump head.
  - e. 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.
  - f. Temperature actuated drain valve; to protect pump in the event of too few nozzles being operated at one time.
  - g. Low pressure gauge; liquid filled, 0-60 psi.
  - h. High pressure gauge; Liquid filled, 0-2000 psi.
  - i. 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.

**B. 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,
  - d. any possibility of "hazing" of the supply air with mineral salts.

#### C. 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.

#### D. 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;
  - a. 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, relays and on-off-auto switches for each solenoid valve with interface to controller, relay for inlet solenoid valve.

E. Manufacturer: MEE Industries, or equal.

## 2.24 HEATING

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#### \*NOTE TO SPECIFIER

If Gas Fired Unit Heaters are not to be used delete Gas Fired Unit Heater section.

If Hot Water Heat is not to be used delete Hot Water Heating section.

If Boilers are not to be used delete Boiler section.

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#### A. GENERAL DESCRIPTION

1. Design requirements
  - a. Inside Temperature: 70 °F
  - b. Outside Temperature: -10 °F

- c. Temperature Difference: 80 °F
- d. Wind 15 MPH

1. System design (*choose one of the following*):

- a. Gas fired heating system to provide 100% of greenhouse system heating load
- b. Hot water heating system to provide 100% of greenhouse system heating load
- c. Hot water heating system shall provide the primary heating load and gas fired unit heaters shall supplement the balance of the heating load.

B. 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. Gas Supply piping and final electrical connection by others.
2. Cabinet shall 20 gauge Stainless steel constructions.
3. Primary heater exchanger shall be 20 gauge non welded stainless steel tubes with curved serpentine design.
4. The burners shall be stainless steel inshot design.
5. The burner ignition shall be an intermittent-duty direct spark pilotless design.
6. A balanced broad blade fan shall be direct driven by a totally enclosed motor selected to match the fan requirements.
7. Units shall be equipped with combination solenoid, safety pilot, pressure regulator and manual shut off valve. Units shall carry the American Gas Association (AGA) certification for safety or CSA Certification.
8. Installation shall include stack with proper saddles or other accessories for a weather tight penetration of the greenhouse skin, and weather cap.
9. Unit heaters shall be as manufactured by Sterling Manufacturing Company.

C. HOT WATER HEATING SYSTEM

1. General Requirements: The heating system for the greenhouse shall be a Delta T Solutions Hot Water Heating System. The system is designed under the following conditions:
  - a. Hot Water Supply: 180 °F
  - b. Hot Water Return: 160 °F
  - c. Temperature Differential 20 °F
  - d. Relief Valve Pressure: 60 psi

- e. Operating Pressure: 12 psi
2. General System Description:
  - a. Hot water heating system with a variable flow supplied to the system based on the quantity zones that have heating demand. The hot water shall be pumped through radiating materials to control heat to the desired temperature in each zone.
3. The system shall consist of:

(enter # zones) heating zones that will be controlled using the following components to maintain the desired zone temperatures:

  - a. Heating Source: The heat source that will be supplying the hot water to the radiating materials: ***(choose one of the following)***
    - i. Supplied by others with the required flow being supplied as per the design drawing.
    - ii. Shall be a natural gas fired boiler.
    - iii. Shall be oil fired boiler.
    - iv. Shall be a steam to hot water generation.
  - b. System Pumps: The pumps shall be centrifugal pumps
    - i. Federal in line-
      - 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.
      - Impeller – single-piece enclosed bronze balanced impellers, with diameters cut for specified condition points.
      - 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.
      - 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.
      - 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.

## c. Grundfos Inline

- The pump shall be a maintenance-free, in-line, single stage, wet rotor type with the motor mounted directly to the pump volute. The pump models shall be furnished as shown on the plans and installed in accordance with manufacturer's recommendations. The pump shall be capable of delivering gallons per minute when operating at a total developed head as shown on the pump schedule shown on the plans.
  - The pump shall be capable of operating continuously at temperatures from 14°F to 230°F (-10°C to 110°C) for closed systems and 32°F to 140°F (0°C to 60°C) for open systems.
  - Maximum working pressure shall be 145 psi (10 bars).
  - The pump volute shall be constructed of close-grained cast iron (closed systems) or bronze (open systems).
  - The impeller, impeller seal ring, rotor can, bearing plate, motor shaft, and rotor cladding shall be constructed of stainless steel. The impeller shall be secured directly to the motor shaft by means of a stainless steel tapered split cone and locking nut.
  - The motor shaft shall have tungsten carbide bearing journals and shall be supported by two aluminum oxide ceramic radial bearings. The motor shaft shall have a stainless steel mounted carbon thrust bearing. The pump shall not have a coupling or mechanical seal.
  - The integral motor shall be of the horsepower, voltage, phase, and frequency as shown on the drawings. For 115, 208, and 230 volt models, the pump shall operate on each of three speeds selected using a built in, three-speed switch (460 & 575\* volt models are two speed only). The motor shall be cooled and lubricated by the pumped fluid and shall require no scheduled maintenance.
  - Furnish GRUNDFOS VersaFlow UPS circulators or approved equal.
- d. System pump control shall be Delta T Solutions variable frequency drive system using a VFD drive by Baldor that will vary the amount of flow based on the quantity of zones that need heat. The input to the drive shall be supplied by the differential pressure switch control package.
- e. Zone Control: Two way valve 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:

- i. Control Valves: Two-way control valves shall be manufactured by Honeywell, Belimo or approved equal. 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, EPDM O-ring and stainless steel stem. Valves provided by and installed by greenhouse contractor.
  - ii. 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.
4. Radiation shall supply total heat loss based on the design criteria using the following materials: (*choose required radiation for application*)
- a. Radiation Fin Tube: Radiating materials shall be the Delta-T Fin SF125 aluminum finned pipe installed around the perimeter low on the wall or under the gutter, using water temperatures up to 230°F and will consist of the following components:
    - i. 1.25" schedule 40 aluminum pipe with 3.25"x 3.25"x 0.025" aluminum fins at 48 fin/ft or 24 fins/ft based on design requirements. Pipe shall have each end grooved to accept the grooved coupling provided.
    - ii. Coupling shall be grooved style with aluminum casting and 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.
    - iii. Elbows shall be sch 40 aluminum sweeps with grooved connections.
    - iv. Expanded metal mesh fin tube covers to be provided over the Fin Tube heating system in compartments with "low" perimeter fin position.
    - v. All aluminum slide brackets shall be used on all fin when attached to side walls.
    - vi. Piping in the greenhouse compartments shall be schedule 40 aluminum pipe and shall be installed with grooved coupling technology. All piping that is exposed and will have casual contact shall be insulated with 1.0 inch fiberglass insulation and be covered with aluminum cover per drawing.

- b. Radiation Radiant heat: Radiating material shall be ½” PEX Cross link Polyethylene tubing with Oxygen barrier installed on 12 inch spacing 2 inches below the concrete surface. Tubing shall be attached to Wire mesh using wire ties every 2 feet. Water temperatures of 90°F to 120°F shall be pumped through the tubing at 20°F temperature difference. Tubing shall be attached to a copper manifold using a crimp ring. Each manifold shall be installed into a Steel / galvanized box in the concrete slab and covered with aluminum Diamond plate cover.
  - c. Radiation Hot water unit heater: Furnish and install where indicated or scheduled on plans, Sterling Model HS horizontal steam/hot water unit heaters. Unit shall be equipped as specified herein. All units shall be installed in a neat and work man like manner in accordance with this specification and the manufacturer's.
    - i. Casings shall be 20 gauge die-formed steel. Casing substrates shall be prepared for finishing with a hot wash, iron phosphatizing, clear rinse, chromic acid rinse and oven drying. Paint finish shall be lead-free, chromate free, alkyd melamine resin base and applied with an electrostatic two-pass system. Finish shall be baked at 350°F.
    - ii. Coil elements and headers shall be of heavy wall drawn seamless copper tubing. Element tubes shall be brazed into extruded header junctions. Pipe connection saddles shall be of cast bronze. Aluminum fins shall have drawn collars to assure permanent bond with expanded element tubes and exact spacing. All Element Assemblies are submersion tested at factory at 250 P.S.I., and are rated at 150 pounds of saturated steam pressure at 366°F, under maximum load conditions. We recommend operating pressure of 75 P.S.I. at 320°F for long life.
    - iii. Motors shall be totally enclosed fan cooled, resilient mounted with class “B” windings. All motors shall be designed for horizontal mounting. Motors under 1/3 H.P. are totally enclosed, frame mounted, 115/1/60 with thermal overload protection and permanently lubricated sleeve bearings with optional solid state speed controller available. 1/3 H.P. (115/1/60) motors are open frame construction, with thermal overload protection and ball bearings. 1/3 H.P. at (230V) and all 1/2 H.P. motors are open frame construction, with thermal overload protection and ball bearings. 1/3 and 1/2 H.P.
5. All main piping in the corridors feeding the zones shall be schedule 40 steel piping using grooved connections to all fittings.

- a. All straight piping shall be insulated with 1 inch fiberglass insulation and covered with aluminum cover.
  - b. All piping shall be labeled with directional arrows and description
  - c. All controls valves shall be tags with metal tags and chain
  - d. All drain valves will be provided with caps attached with chain
  - e. All necessary elbows, nipples, drain plugs, air bleeders, expansion joints, etc.; to complete the system should be included in the system.
6. Boiler

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**\*NOTE TO SPECIFIER**

If Boilers are not to be used delete this section.

Select one of the below items a or b for the appropriate Boiler Specification.

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- a. The Fan Assisted Boiler shall be **RBI Dominator** Model DB\_\_\_\_\_ having an input rating of \_\_\_\_\_ MBH and \_\_\_\_\_ MBH output. The Boiler shall operate on \_\_\_ NATURAL GAS \_\_\_ PROPANE GAS. The efficiency shall be up to 85.1%.
  - i. The Boiler shall be designed certified and tested by International Approval Services. The Boiler shall meet the requirements of ANSI Standard Z21.13 and the Canadian Gas Association Standard CAN1-3.1. SCAQMD certified (sub 30 ppm NOx).
  - ii. The Boiler shall operate on negative stack pressure and Category I according to ANSI Standards or Class I according to CGA Standards. The Boiler shall operate on positive stack pressure and Category III vent material. A listed stainless steel vent must be used. The Boiler shall be approved for indoor or outdoor installation. The Boiler shall be approved for Sidewall, Direct Vent Vertical and Direct Vent Horizontal sealed combustion up to 35' equivalent length. Flue outlet shall be field convertible to allow venting from top or rear outlet of Boiler. Side air intake standard, rear intake optional on 750 - 2100 only.
  - iii. The combustion chamber shall be sealed and completely enclosed with high temperature ceramic fiberboard insulation. The burners shall be constructed of "4509 Uginox" stainless steel alloy and fire on a horizontal plane. The Boiler shall have two-speed integral combustion air blowers to precisely control the fuel/air mixture for maximum efficiency across the firing range.

- iv. The heat exchanger shall be inspected and bear the A.S.M.E. Section IV seal of approval. The A.S.M.E. Section IV seal of approval will not be provided as standard for jurisdictions not requiring the A.S.M.E. Section IV seal of approval. The heat exchanger shall be a two pass design with maximum working pressure of 160 psi. The water tube shall be of straight 7/8" I.D., .064" minimum wall thickness; integral finned copper tube, 7 fins per inch, with a fin height of 3/8". The water tubes shall be set horizontally with heavy galvanized steel "V" baffles tightly secured above the tubes throughout the length of the water tubes. Each end of the water tubes shall be strength rolled onto a steel tube sheet. The headers shall be secured to the tube sheet by properly placed stud bolts, flange nuts and with the use of o'rings. Headers will be of cast iron construction. O'rings must be constructed of EPDM and Silicone, capable of withstanding temperature of 540° F, 282° C. The use of red o'rings constructed of Neoprene and Silicone with temperature ratings of 250° F, 121° C will not be allowed. The Boiler shall have a heat exchanger drawer guide rail so that the heat exchanger may slide out for ease of service and maintenance. A pressure relief valve of 45 lb/sq. in. shall be equipped with the boiler.
- v. Boiler staging will be controlled by a PID logic based two-stage or four-stage set point control. A relay logic board will incorporate all relay functions and purge time delays. Standard control system will be a United Technologies Controls 600A Series spark-to-pilot proven ignition with full flame monitoring capability. Hot surface ignition systems of any type will not be permitted. The control panel shall have a master switch with an indicating light and sequential and diagnostic indicator lights. Standard controls shall include factory mounted: high limit control with manual reset, aquastat, low air and blocked flue pressure switches to monitor fan operation, inlet and outlet temperature gauges, flow switch, relief valve and 24 VAC control circuit.
- vi. The firing mode shall be one of the following:
- **STANDARD 2-STAGE-** (MODELS 600 - 950 )
  - **4-STAGE** - (MODELS 1050 - 2100 ONLY)
- vii. The Venting mode shall be one of the following:
- Standard Venting
  - Horizontal & Vertical Outside Air Venting
  - Thru-Wall Venting

- Outdoor Venting
- viii. The gas train shall include a main ball valve (600 - 2100 only), pilot valve, pilot gas pressure regulator, main gas valve, safety valve (600 - 2100 only), and firing valve. Gas train shall be CSD-1 approved
- ix. The Cabinet construction shall be Brushed stainless steel
- b. The High Efficiency Condensing Boiler shall be **RBI Futura Fusion** Model CB\_\_\_\_\_ having an input rating of \_\_\_\_\_ MBH and \_\_\_\_\_ MBH output. The Boiler shall operate on \_\_\_NATURAL GAS \_\_\_PROPANE GAS . The efficiency shall be up to 99.1%.
- i. The Boiler shall be designed certified and tested by International Approval Services. The Boiler shall meet the requirements of ANSI Standard Z21.13 and the Canadian Gas Association Standard CAN1-3.1. SCAQMD certified (sub 30 ppm NOx).
  - ii. Water heaters shall be CSA design certified as a condensing boiler. Water heaters shall be equipped to accept return water temperatures as low as 40°F, 4°C and operate in the condensing mode at all times. Water heaters shall be designed for a minimum of 4:1 continuous turn down with constant CO<sub>2</sub> over the turndown range. The water heater shall operate with natural gas or propane and have a I=B=R certified input rating as noted on the drawings, and a thermal efficiency rating of 94.9% at rated input and 99.1% at minimum input. The water heater shall incorporate a symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The water heater will automatically adjust input for altitude and temperature induced changes in air density. The water heater will use a proven pilot interrupted spark ignition system. The water heater shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The design shall provide for silent burner ignition and operation. Burner shall be premix radial-type and fire in a 360° vertical pattern. Water heater shall be able to vent a horizontal distance of 60 equivalent feet.
  - iii. The water heaters shall be provided with stainless steel jacket panels, minimum 16 gauge, with push-button fasteners for easily accessing all serviceable components. Sheet metal screws may not be used in the securing of jacket panels to the boiler. The water heaters shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All

accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.

- iv. The combustion chamber shall be constructed of minimum 16 gauge stainless steel. Aluminum or galvanized steel is not acceptable. An access door shall be provided for ease of service and inspection of the heat exchanger.
- v. Gas Burner: Metal fiber mat premix burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. Burner composition shall be Fecralloy™. The burner shall be easily removed for maintenance without the disruption of any other major component of the water heater. Ignition electrodes shall be removed for inspection and proper alignment without removing the burner. A window view port shall be provided for visual inspection of the flame during firing.
- vi. Ignition Components: The ignition hardware shall consist of dual Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment. Electrodes must be capable of removal while leaving the burner intact. Hot surface ignition systems of any type *will not* be accepted.
- vii. Rated Capacity: The water heater shall be capable of operating at rated capacity with pressures as low as 2" W.C. at the inlet to the burner pressure regulator. Water heaters that cannot provide full BTUH inputs at 2" W.C. will not be accepted.
- viii. The burner shall be capable of 99.1% efficiency without exceeding a NOx reading above 20 ppm.
- ix. The burner and gas train shall be provided with the following trim and features:
  - Burner Firing: Full modulation with 3:1 turndown @ Continuous CO<sub>2</sub>
  - Burner Ignition: Intermittent spark
  - Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.
  - Flue Gas Collector: Enclosed combustion chamber with integral combustion air blower and single venting connection.

- Gas Train: Manual gas valves (2), main gas valve (motorized), 'B' valve, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted.
- x. Safety Devices: Optional high/low gas pressure switches, air flow switch, and blocked flue detection switch. All safeties to be factory mounted.
- xi. The heat exchanger shall be inspected and bear the A.S.M.E. Section IV seal of approval. The heat exchanger shall be a four-pass heat exchanger with a maximum working pressure of 160 psi. The heat exchanger's vertical design shall provide equal amounts of heat transfer throughout the entire heating surface. Each heat exchanger shall have copper tubes, with an integral copper finned tube of 7/8" I.D., .064" minimum wall thickness, 7 fins per inch, with a fin height of 3/8". Each end of the water tubes shall be strength rolled into the header. The heat exchanger shall be gasket less. Each individual tube can be retubed without the disturbance of the surrounding tubes. A pressure relief valve of 125 lb/sq in shall be equipped with the water heater and factory mounted. The headers shall be of bronze construction only; cast iron shall not be acceptable.
- xii. The secondary heat exchanger shall be inspected and bear the ASME Section VIII seal of approval. The heat exchanger shall have a maximum working pressure of 160 psi. Each heat exchanger shall be constructed of 316L stainless steel throughout the internal vessel and 304L stainless steel for the external shell. Secondary heat exchangers constructed of finned copper or cupronickel tubes shall not be acceptable.
- xiii. Safety Relief Valve: ASME rated, factory set to protect water heater and piping as per schedule/drawings.
- xiv. Gauge: Combination water pressure and temperature shipped factory installed. LCD inlet/outlet temperature gauges to be an integral part of the front water heater control panel to allow for consistent easy monitoring of temperatures factory mounted and wired.
- xv. Flow Switch: Prevent burner operation when water falls below a safe level or when water flow is low. Flow switch shall be factory mounted and wired. Provision for installation of a low water cut off shall be provided.
- xvi. The boiler control package shall be a MTI Heat-Net or equivalent, integrated boiler management system. The control system must be integral to each boiler, creating a control network that eliminates the need for a "wall mount" stand-

alone boiler system control. Additional stand-alone control panels, independent of a Building Management System (BMS), shall not be allowed to operate the boiler network.

- xvii. The Heat-Net control shall be capable of operating in the following ways:
- As a stand-alone boiler control system using the Heat-Net protocol, with one “Master” and multiple “Member” units.
  - As a boiler network, enabled by a Building Management System (BMS), using the Heat-Net protocol, with one “Master” and multiple “Member” units.
  - As “Member” boilers to a Building Management System (BMS) with multiple input control methods.
- xviii. Operating Controls: Water heater shall be provided with a Honeywell RM7800 series digital flame safe guard. The flame safeguard shall be capable of prepurge cycles.
- xix. Operating Temperature Control: Shall be a digital P.I.D. controller adjustable from 40°F to 240°F, 4°C to 116°C. Control shall have the capability to provide outdoor air reset function. Control shall be factory mounted and sense the inlet and outlet temperature of the water heater through a resistance sensor.
- xx. High Limit: Temperature control with manual reset limits boiler water temperature in series with the operating control. High limit shall be factory mounted and sense the outlet temperature of the boiler through a dry well.
- xxi. The Venting mode shall be one of the following:
- Standard Venting
  - Horizontal & Vertical Outside Air Venting
  - Thru-Wall Venting
  - Outdoor Venting
- xxii. The gas train shall include a main ball valve (600 - 2100 only), pilot valve, pilot gas pressure regulator, main gas valve, safety valve (600 - 2100 only), and firing valve. Gas train shall be CSD-1 approved.

- D. System control - Environmental Controller will control the zone actuators based on air temperature inside each compartment and corridor.
- E. Engineering and Design for the heating system shall meet uniform mechanical code. All drawings shall be blue lined drawings on standard D size, Stamped by mechanical engineer.

- F. Installation: Full installation of the above system will be responsibility of the greenhouse contractor. The installation shall be done with a crew experienced for not less than 3 years of installing hot water heating systems.

## **2.25 HORIZONTAL AIR FLOW FANS**

- A. Air distribution system shall be 16" diameter horizontal air flow fansas manufactured and supplied by Rough Brothers, Inc. 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.

## **2.26 RETRACTABLE SHADE/HEAT RETENTION CURTAIN SYSTEM**

### **A. GENERAL**

1. Independently motorized Shading and Heat Retention Curtain System(s) designed for size as shown on the drawings and as manufactured and supplied by Rough Brothers, Inc.
2. Curtains are to travel simultaneously from purlin to purlin and travel up the slope parallel to the roof. Horizontally drawn or flat shade systems are not acceptable. The system fabric when not active should nest inside the purlin so as not to add additional shading.
3. Curtains will have U.V. stabilized reinforcing tape used in reinforcing the material for the use of cloth hooks. Cloth hooks will be factory installed.
4. All curtains are to come precut with ends serged to prevent any unraveling of the material.
5. Curtain fabric to be flame retardant and carry ASTM E 84 and NFPA certifications.
6. 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. 14R	Polyester & Aluminum	45% shade factor	52% energy savings
X.L.S. 15R	Polyester & Aluminum	50% shade factor	57% energy savings
X.L.S. 16 R	Polyester & Aluminum	65% shade factor.	62% energy savings
X.L.S. 17 R	Polyester & Aluminum	75% shade factor.	67% energy savings
X.L.S.	OBSURA A & B aluminized blackout fabric	99% shade factor	75% energy savings

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**B. MOTORS AND CONTROLS**

1. System to be independently operated by one motor per zone.
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 must be integrally mounted into the drive unit and protected from the elements with sealed covers.
5. Drive unit interface panel to be pre-wired for computer hookup, and be 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 ¾" minimum diameter and hold 18 feet of cable.
4. Driveline is to contain two driveline drums per drive cable to provide simple adjustment of the cable tension.
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.

## 2.27 SUPPLEMENTAL PLANT GROWTH LIGHTING

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

High Pressure Sodium fixtures (400w, 600w, 750w or 1000w) 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.
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.

#### 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.
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.

### B. METAL HALIDE FIXTURES (MH)

Metal Halide fixtures (400w or 600w only) shall have the following characteristics:

1. 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.
2. 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.
3. 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.
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.

Remote Units – Only in 400W and 1000W

5. 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.
6. 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.
7. Bulb: Metal Halide bulb CSA/UL approved, initial output and life expectancy will be provided according the manufactures specifications.
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.

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

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

1. 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.

2. 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.
3. 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.
4. 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.
5. 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. 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;
  - a. on-time misting 1-250 seconds
  - b. Minimum cycle time 1 till 250 minutes
  - c. Maximum cycle time 1 till 250 minutes
  - d. Temperature input
  - e. Misting valves starting on time or temperature
  - f. Automatically adjustment of the misting cycle by the temperature.

- g. Pump output option
- h. 115vac

C. Manufacturer: DRAMM Corporation, or equal.

## 2.29 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, exhaust fan shutter motors, 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.
  8. Testing and Owner Training: Allow up to two consecutive days on-site for testing and owner training by environmental controls manufacturer.
- H. Provide pre-wired NEMA 3R Motor Control Panel (MCP) cabinet for control of required greenhouse components and systems as provided by the greenhouse manufacturer. The MCP cabinet shall:
1. Have a NEMA 3R cabinet with locking capability.
  2. Have an externally, front panel, main power disconnect switch.
  3. Have an internally, inside of front panel mounted vent and shade motor interface control (reversing relays).
  4. Have all required load contactors, contact relays, circuit breakers and dry set of contacts for owner connected low/high temperature alarm system.
  5. Be UL approved.
  6. Line voltage and low voltage wiring and conduit by Electrical Contractor.
- A. If supplemental crop light fixtures are to be provided and mounted by the greenhouse manufacturer, provide NEMA 3R fan cooled Lighting Control Panel (LPC) cabinet. The LCP cabinet shall:

1. Have a NEMA 3R cabinet with locking capability.
  2. Have a 100 amp main breaker for 480 V AC, 3-phase, 3-wire feed.
  3. Have six (6), 2-pole 20 amp, remote control circuit breakers.
  4. Be UL approved.
  5. Line voltage and low voltage wiring and conduit by Electrical Contractor.
- J. 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.

## **PART 3 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 Greenhouse Manufactures recommendations.
- C. Greenhouse Manufacturer is responsible for all unloading of greenhouse materials, systems, equipment and are to provide any lift or installation required equipment.

### **3.02 DISSIMILAR MATERIALS**

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

### **3.03 GROUTING**

- A. After the Greenhouse Manufacturer 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, if required.

**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 Manufacturer. All flashing and counter-flashing shall be minimum 1/16" aluminum.

**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 (2) two site visits by Greenhouse Manufacturer project management, Greenhouse Manufacturer personnel shall instruct owner on use of greenhouse, systems and equipment. 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. Any greenhouse warranty item within the warranty period shall be directed to and be the direct responsibility of the Greenhouse Manufacturer, including that of its material suppliers, vendors and subcontractors.
- B. Written warranty conforming to the above paragraph to be submitted as a part of the approval drawing submittal package.