ADDENDUM NUMBER 02 TO THE BID DOCUMENTS

To all general contract bidders of record on the Bid Proposal:

BID DOCUMENT: 17/18 MB5
Building 11 Renovation # I50-35613
College of Marin – Indian Valley Campus

Addendum Date: October 9, 2017

A. This addendum shall be considered part of the bid documents for the above mentioned project as though it had been issued at the same time and shall be incorporated integrally therewith. Where provisions of the following supplementary data differ from those of the original bid documents, this Addendum shall govern and take precedence.

B. Bidders are hereby notified that they shall make any necessary adjustments in their estimates as a result of this Addendum. It will be construed that each bidder's proposal is submitted with full knowledge of all modifications and supplemental data specified herein.

The bid documents are modified and clarified, as follows:

Bid questions and responses:

1. The demolition notes say that "all demo work is be done by others." Will the owner to have all demolition, including roof demo, completed prior to the start of construction? Or is this to be the contractors responsibility?

   RESPONSE: Demolition note 1 says "ALL DEMOTION WORK BY OTHER U.O.N. IN DEMOLIITION KEYNOTES, NOT EVERY ITEM OF (E) WORK TO BE DEMOLISHED IS INDICATED ON THE DRAWINGS." Refer to keynotes. Demo of roof to be contractor's responsibility.

2. Please reference detail 1 on sheet A9.20. The detail calls for new elevator controls without a spec section provided. Please provide appropriate elevator specifications.

   RESPONSE: See Addendum 01 revisions to A9.20 and A9.21

3. Please reference detail 2 on sheet A8.3. The detail calls for new fiber reinforced slats with aluminum bar inserts. Please provide spec section for this material as section 06 40 05 does not exist within current spec book.

   RESPONSE: See Addendum 01 for missing spec section 06 40 05 for Resysta material for composite wood planks.

4. Please reference detail 7 on sheet 8.2 which calls for Resysta fiber reinforced hollow plank siding. Please provide spec section as section 06 04 05 does not exist with current spec book.

   RESPONSE: See Addendum 01 for missing spec section 06 40 05 for Resysta material for composite wood planks.

5. Other than the elevator and stairs, what is the average height of walls on the second floor?

   RESPONSE: See A3.11 for typical height of 9'-6".

6. Is there any painting or coating system required on the exterior of Building 11 for this project?

   RESPONSE: Patch and paint around exterior openings and areas affected by new work, prep. of existing trellis frame for new paint, paint at new exterior door 112, and paint at new roof fascia board

7. On both drawing pages (A6.2 and A6.3) notes 608 and 614 refer to sand blasting existing paint on particular glulam beams and rafters to prepare for a clear coat sealer. (1) Having viewed the beams first hand, there are areas on the glulams that currently have paint and are not represented on the drawings. Do you want every area where there is current paint, to be removed?

   RESPONSE: Yes, to the extent possible without damaging the glulam and removing significant thickness.

8. At the walk it was verbally expressed that the only the horizontal glulams (running along axis "2" and "B" on pg.A6.3) were being suggested for receiving a clear coat. But on drawing A6.3 some of the other beams and rafters are called out. Can you advise?

   RESPONSE: Remove paint on all exposed wood surfaces at glulam beams, roof beam and rafters where occur at 2nd floor. From the site walk, paint primarily is on the horizontal glulam beams along axis 2 and B on A6.3 (located on B.O. Beam elevation 21'-10 ½").

9. Is it possible to point out which glulam beams or rafters you would like to receive a clear coat?

   RESPONSE: No clear coat finish is needed.

10. And as far as preparation is concerned, is it possible that the removal of paint can be up to the contractor, or do those areas need to be sandblasted, which may definitely alter the look compared to the other surfaces?

RESPONSE: The intent is to remove existing paint finish from existing surfaces and refinish it to provide for an even consistent look to the glulam beams. I will defer to contractor for means and method for paint removal and for providing a consistent finish appearance of the natural material. An example can be hand sanding.

11. Can you also provide specs for the clear coat process including preparation (beyond removing existing paint), product, application, etc.?

    RESPONSE: No clear coat finish is needed.

12. I am a Building Insulation subcontractor and would like to bid on that portion of the job will I be bidding to a G.C. or is the Insulation a stand-alone package that I need to bid to the district? If I am bidding to an approved G.C. do you have a bidders list I can look at?

    RESPONSE: The insulation portion of the project is not being bid as a separate contract. All bids must be submitted as single lump sum bid for the entire project. Bidders list was sent out to all participants of the Mandatory Pre-Bid Conference.

13. Section 23 05 00 paragraph 1.05.A calls for 2D flat shop/coordination drawings. Section 23 05 00 paragraph 1.06.A & B calls for 3D As-Builts in Revit. How do we submit a 3D model and drawing when none are being produced?

    RESPONSE: It is the mechanical contractor's responsibility to provide fully coordinated (2D) shop drawings per section 23 05 00. A 3D model will not be required, the specifications will be updated to reflect this.

14. Section 00 10 00 calls for only Delta Controls for the BMS work on the project. Section 23 09 00 paragraph 2.01.A names Automated Logic, Delta Alerton, Siemens, Johnson Controls and Trane as acceptable manufacturers/installers. Which is correct?

    RESPONSE: 00 10 00 is correct. Only Delta controls will be accepted as directed by the college. Section 23 09 00 will be updated to reflect this.

15. Will a specification for the skylight be provided?

    RESPONSE: Skylight submittal is attached for reference.

16. Can you clarify if the exterior windows will be clear glass only or a Low E.

    RESPONSE: GL-1 Exterior windows will be Low E, 1" insulated glazing with tempered glazing on outside pane per Novato local ordinance for Wildland Urban Interface requirements. GL-2 shall be 1/2" temp. clear glass.

17. Spec: 084113 Interior Aluminum Storefronts call out for the Old Castle FG 2000 which is an exterior Storefront. The storefront details show an interior system like Doormerica, Rayco, Wilson. Please clarify what will be required.

    RESPONSE: Storefront system should be interior storefront. The Old Castel G 2000 system is an interior storefront system. This has been confirmed with manufactuer.

18. Door E107 in on the exterior elevation but not in the door schedule. Looks to be a storefront door. Please clarify.

    RESPONSE: E107 is an existing door. No new work for that door.

19. At the job walk we were informed that the weight limit for the bridge was 20 tn, however the bridge has a sign posted stating a 15 tn weight limit. Please clarify the actual limit for the bridge.

    RESPONSE: The weight limit of the bridge (bridge #4) adjacent to Building 11, that goes over the creek, is 15 tons.

20. Would you be able to provide me with the engineers estimate for the Building 11 Renovation project?

    RESPONSE: There is no engineers estimate for 17/18-MB5: Building 11 Renovation project.

21. What is the engineers estimate for this project?

    RESPONSE: There is no engineers estimate for 17/18-MB5: Building 11 Renovation project.

Attachments issued with Addendum 02:

1. Spec. Section 23 05 00 Common Work Results for HVAC
2. Spec. Section 23 09 00 Instrumentation and Controls for HVAC
3. Skylight submittal

_____

Name of Architect or Engineer in General Responsible Charge

_____ _____

Signature of Architect or Structural Engineer Date

End of Addendum #02

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, General Requirements Specification Sections, apply to this Section.

B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

C. Sections of Division 23, HVAC are interrelated. When interpreting any direction, material, and method specified in any section of Division 23, HVAC, consider it within the entirety of Work in Division 23, HVAC.

1.02 SUMMARY

A. The intent of Division 23, HVAC Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include Work specified in Division 23, HVAC and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Division 23, HVAC Specifications and the accompanying Drawings are complementary. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications supersede drawings in case of conflict.

C. Imperative language is frequently used in Division 23, HVAC Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.

D. The Drawings that accompany the Division 23, HVAC Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

1.03 RELATED WORK

A. The General and Supplemental Conditions apply to this Division, including but not limited to:

1. Drawings and specifications.

2. Public ordinances, permits.

3. Include payments and fees required by governing authorities for work of this Division.

B. Division 01, General Requirements, General Requirements, applies to this Division.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Products and equipment prohibited from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.

2. General: Work and materials conforms to the local and State codes, and Federal, State and other applicable laws and regulations.

3. Contractor responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment: New and defective free. Work good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire mechanical system and apparatus operate at full capacity without objectionable noise or vibration.

E. Install equipment level and true. Housekeeping pads and curbs account for floor or roof slope.

F. Materials and Equipment:

1. Each piece of equipment furnished meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.

2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.

3. Furnish materials and equipment of size, make, type, and quality herein specified.

4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:

1. General: Install materials in a neat and professional manner.

2. Manufacturer’s Instructions: Follow manufacturer’s directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 23, HVAC Specifications, obtain clarification before starting work.

H. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.

2. Additional openings required in building construction made by drilling or cutting. Use of jackhammer is specifically prohibited.

3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.

4. Do no pierce beams or columns without permission of Architect and then only as directed.

5. Restore new or existing work cut or damaged to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces repaired, refinished, and left in condition existing prior to commencement of work.

1.05 SUBMITTALS

A. Shop Drawings:

1. Indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of piping, ductwork and equipment installations. Shop Drawings new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. Drawings the same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. Fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.

2. Prepared in two-dimensional format.

3. Include but are not limited to:
   a. Complete floor plans with sheet metal and HVAC piping to a minimum of 1/4-inch equals 1-foot scale.
   b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equals 1-foot scale.
   c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
   d. Controls and Instrumentation: Scale and drawing sizes to suit controls supplier.
   e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment not less than 1/4-inch equals 1-foot scale.
   f. Superplot plans of above ground work with a colored overlay of trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.
   g. Superplot plans of below ground work with a colored overlay of trades including, but not limited to, structural footings and foundation, HVAC piping, civil piping, plumbing piping, and power conduit to a minimum of 1/2-inch equals 1-foot scale.
   h. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.

i. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
j. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.

4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:

1. In general, submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.

2. List the name of the motor manufacturer and service factor for each piece of equipment.

3. Indicate equipment operating weights including bases and weight distribution at support points.

4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:

1. Shop Drawings and Product Data:
   a. Refer to Division 01, General Requirements for additional requirements related to submittals.
   b. Submit electronic copies of shop drawings and product data for Work of Division 23, HVAC in PDF format with each item filed under a folder and labeled with its respective specification section number, Article and paragraph and mark if applicable.
   c. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
   d. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, included with the original submittal. Controls and Instrumentation submittals may lag but complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

D. Contractor Responsibilities:

1. Submit submittals one time and are in proper order.

2. Ensure that equipment will fit in the space provided.

3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.06 AS-BUILT DRAWINGS

A. Provide ~~3D~~ **2D** ~~model~~ **CAD files** and record drawings at the end of the project on CD-ROM.

B. ~~3D~~ **2D** ~~model~~ **files** in the following format:

1. ~~Revit~~**AutoCAD**

C. Record Drawings: Provide hard copies and pdf format.

1. Drawings include the following:
   a. Project Specific Title block.
   b. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of ~~the BIM~~ coordination, RFIs, ASIs, Owner Changes and Field Coordination.

1.07 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

A. Refer to Division 01, General Requirements for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature on 8-1/2-inch by 11-inch sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover phases of control.

D. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

1.08 PROJECT CONDITIONS

A. Existing Conditions: Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work. Include related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check information and report discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, the City and Utility Company.

1.09 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.10 PROVISIONS FOR LARGE EQUIPMENT

A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.11 TEST REPORTS AND CERTIFICATES

A. Submit one copy of test reports and certificates specified herein to the Architect.

1.12 SUBSTITUTIONS

A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.01 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.02 PIPE AND DUCT SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.03 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:

1. Floor Plates: Cast brass, chromium plated.

2. Wall and Ceiling Plates: Spun aluminum.

2.04 MACHINERY GUARDS

A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.

B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.

C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.

D. Meet OSHA requirements including back plates.

E. Provide inlet and outlet screens on fans in plenums or where exposed to personnel.

2.05 ELECTRICAL EQUIPMENT

A. General: Equipment and installed work as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.

C. Motors – AC Induction:

1. Furnish as integral part of driven equipment.

2. Drip proof induction type with ball bearings unless noted otherwise.

3. Motors 1 hp and above premium energy efficient type, except for emergency equipment motors.

4. Built to NEMA Standards for the service intended.

5. Rated for voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.

6. Energy Efficient Motors:
   a. Baldor
   b. Westinghouse
   c. General Electric
   d. Or approved equal.

7. Meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5
7.5	5.6	87.5	91.7	91.7	91.0
10	7.5	88.5	91.7	91.7	91.7
15	7.5	88.5	91.7	92.4	91.7
20	15.9	90.2	92.4	93.0	92.4
25	18.8	91.0	93.0	93.6	93.0
30	22.5	91.0	93.6	94.1	93.0

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
40	30.0	91.7	94.1	94.5	93.6
50	37.5	92.4	94.1	94.5	94.1
60	45.0	93.0	94.5	95.0	94.1
75	56.3	93.0	95.0	95.4	94.5
100	75.0	93.0	95.4	95.4	95.0
125	93.8	94.5	95.4	95.4	95.4
150	112.5	94.5	95.8	95.8	95.4
200	150.0	94.5	95.8	96.2	95.8
250	187.5	94.5	95.1	96.2	95.1
300	225.0	94.5	95.3	96.2	95.3
350	225.0	94.5	95.3	96.2	95.3
400	300.0	94.5	95.4	96.2	95.4
450	337.5	94.5	95.5	96.2	95.5
500	375.0	94.5	95.6	96.2	95.6

8. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.

9. Refer to individual product sections for additional motor requirements.

10. Furnish motors on belt drive equipment of nominal nameplate horsepower not less than 120 percent of equipment brake horsepower required for performance specified.

11. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.

12. Motors controlled by variable frequency drives inverter duty rated and have Class F insulation or better. Withstand repeated voltage peaks of 1600 volts with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.

13. Motors served from variable frequency drives equipped with shaft grounding system which provides a path for current to flow between the shaft and motor frame. SGS or equal.

14. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.

15. Motors installed on cooling towers totally enclosed type TEFC.

D. Motors – Electronic Commutation (EC):

1. Furnished as integral part of driven equipment.

2. Permanently lubricated with ball bearings unless noted otherwise.

3. Internal motor circuitry converts AC power supplied to the motor to DC power to operate the motor.

4. Speed controllable down to 20 percent of full speed.

5. Motor efficiency at a minimum of 85 percent at all speeds.

6. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.

7. Refer to individual product sections for additional motor requirements.

8. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.

9. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.

E. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

F. Equipment Wiring:

1. Interconnecting wiring within or on a piece of mechanical equipment provided with the equipment unless shown otherwise.

2. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

G. Control Wiring: Control wiring for mechanical equipment provided under Section 23 09 00, Instrumentation and Controls for HVAC.

H. Codes: Electrical equipment and products bear the UL label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.01 ACCESS PANELS

A. Install in accord with manufacturer's recommendations, coordinated with architectural features.

B. Provide 2-hour fire rated doors where required bearing the UL label.

C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

A. Interior Floor and Wall Sleeves:

1. Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork.

2. Where pipe or ductwork is insulated, insulation pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve.

3. Penetrations through mechanical room and fan room floors watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves Through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping or duct material, size and service.

C. Sleeves specified or indicated at fire damper penetrations take precedence over this article.

D. Exterior Wall Sleeves Below Grade:

1. Provide water tight sleeves. Install at pipes entering building below grade and where shown.

2. Adjust to provide positive hydrostatic seal.

3. Follow manufacturer's procedure for installing and tightening seal.

4. Secure sleeves against displacement.

E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

G. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

H. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated.

I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members provided so pipes are floor supported.

J. Special sleeves detailed on drawings take precedence over this Section.

3.03 CLEANING

A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.04 EQUIPMENT PROTECTION

A. Keep pipe, ductwork and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.05 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.06 FLOOR, WALL, AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates not to penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting. Exposed work under this division receives either a factory painted finish or a field prime coat finish, except:

1. Exposed copper piping.

2. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:

1. Insulation: Not painted.

2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.

3. Steel Valve Bodies and Bonnets: One coat of black enamel.

4. Brass Valve Bodies: Not painted.

5. Equipment:
   a. One coat of grey machinery enamel.
   b. Do not paint nameplates.

6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers and registers flat black.

C. Concealed Spaces (above ceilings, not visible):

1. Insulation: Not painted.

2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.

E. Roof Mounted Equipment: Paint two coats of exterior machinery enamel. Color as selected by Architect. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.

F. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes comply with ANSI A13.1.

3.08 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.09 ELECTRICAL EQUIPMENT

A. Ductwork or piping for mechanical systems not serving electrical space not installed in switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Ductwork or piping for mechanical systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

A. Make final connections to equipment specified in sections other than Division 23, HVAC of the specifications and Owner furnished equipment in accordance with manufacturer’s instructions and shop drawings furnished and as indicated.

B. Piping:

1. Connections include steam supply, steam vent, and condensate.

2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.

3. Support piping connections independently to prevent undue strain on equipment.

C. Ductwork: Make exhaust connections to fume hoods, emergency generator radiators, and any other processing, laboratory, or kitchen equipment in strict accordance with manufacturer's instructions.

D. Engine Exhaust: Make connections as necessary for complete working installation to the emergency generators as indicated and specified.

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SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The provisions of Division 23, HVAC, Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.02 SUMMARY

A. This Section includes:

1. Control Devices
2. DDC Field Panels
3. Connection to Existing Network
4. BACnet Compatibility
5. Operator Interface System
6. Application Programs
7. Input/Output Functions
8. Uninterruptable Power Supply
9. Energy Management System

B. Related Sections include:

1. Section 22 05 93, Testing, Adjusting and Balancing for Plumbing
2. Section 23 21 13, Pipe and Pipe Fittings HVAC
3. Section 23 08 00, Commissioning for HVAC

1.03 QUALITY ASSURANCE

A. Provide control work by single company with specialists in the type of work required, so that only one control manufacturer is responsible for control and automation work for project.

B. Provide coordination with other contractors or subcontractors for work required by other trades for accomplishment of control work.

C. Prior to substantial completion, controls contractor must demonstrate to Owner that system is operating per the Specifications and final adjustments have been made as approved.

D. System, including components and appurtenances, configured and installed to yield a Mean Time Between Failure (MTBF) of at least 1,000 hours.

1.04 SUBMITTALS

A. System Drawings: Prepare on AutoCAD format and include the following:

1. Equipment installation, block diagrams, and wiring diagrams.

2. DDC panel physical layout and schematics.

3. Sensor and control wiring and installation drawings which identify each component and show interconnected or interlocked components.

4. Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications.

5. Details of connections to power sources, including grounding.

6. Details of surge protection device installations.

7. Instrumentation and control diagrams.

8. Complete a written description of control sequences.

9. List of connected data points, including DDC panels to which they are connected, and input device (sensor, etc.).

10. Valve and damper schedules indicating flows, pressure drops, CVs, and actuator type.

11. Graphics: System graphics for review prior to implementation of programming.

B. Equipment Data: Complete data for materials, including field and system equipment.

C. Software Data:

1. Submittals consist of complete descriptions of system, command, and applications software as specified.

2. Include description of control sequences which are software based using detailed logic flow diagrams.

3. Diagrams indicate logic used to achieve control sequence of calculation specified, and show relationship between control sequence and application software packages specified.

D. Testing Submittals:

1. Provide test plan and test procedures for approval.

2. Explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system.

3. Test plan and test procedures demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.

E. Operation and Maintenance Manuals:

1. Provide three complete sets of manuals bound in loose-leaf binders within 30 days after completing acceptance tests.

2. Identify each manuals contents on cover.

3. Manuals include names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of nearest service representatives for each item of equipment and each system.

4. Place tab sheets at beginning of each chapter or section and at beginning of each appendix.

5. Final copies delivered after completion of the acceptance tests include modifications made during installation, checkout, and acceptance.

6. Operation and Maintenance Manuals to include hardware manual, software manual, operations manual, and maintenance manual.

7. Hardware Manual: Furnish a hardware manual describing equipment provided, including:
   a. General description and specifications.
   b. Installation and checkout procedures.
   c. Equipment electrical schematics and layout drawings.
   d. System schematics and I-O wiring lists.
   e. Alignment and calibration procedures.

8. Software Manual:
   a. Describe furnished software.
   b. Oriented to programmers and describe calling requirements, data exchange requirements, data file requirements and other information necessary to enable proper integration, loading, testing, and program execution.
   c. Provide one software manual per Operator's Terminal.

9. Operator's Manual: Provide procedures and instructions for operation of the system, including:
   a. DDC Panels and Peripherals
   b. System start-up and shutdown procedures.
   c. Use of system, command, and applications software.
   d. Alarm Presentation
   e. Recovery and Restart Procedures
   f. Report Generation
   g. System Schematic Graphics
   h. Provide one Operator's Manual per Operator's Terminal

10. Maintenance Manual: Provide descriptions of maintenance for equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

11. Acceptance Test Forms: Maintenance manual includes copies of signed-off acceptance test forms.

1.05 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:

1. General: Provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.

2. Acceptance Test: Demonstrate compliance of completed control system with contract documents. Demonstrate using approved test plan, physical and functional requirements.

B. Training:

1. General:
   a. Conduct training courses for designated personnel in operation and maintenance of system.
   b. Oriented to specific system being installed under this contract.
   c. Provide trainee with two additional copies provided for archival at project site.
   d. Manuals include detailed description of the subject matter for each lesson.
   e. Delete copies of audiovisuals to Owner.
   f. Training day is defined as 8 hours of classroom instruction, including two, 15-minute breaks and excluding lunch time, Monday through Friday, during normal first shift in effect at training facility.
   g. Notification of any planned training given to the Owner's representative at least 15 days prior to the training.

2. Operator's Training I:
   a. Teach first course at supplier's facility for period of two consecutive training days.
   b. Upon completion, each student, using appropriate documentation, perform elementary operations with guidance and describe general hardware architecture and functionality of system.

3. Operator's Training II:
   a. Teach second course at project site for a period of one training day after completion of Contractor's field testing.
   b. Include instruction on specific hardware configuration of installed system and specific instructions for operating the installed system.
   c. Upon completion, each student able to start system, operate the system, recover the system after failure, and describe the specific hardware architecture and operation of system.

4. Operator's Training III:
   a. Teach third course at project site for period of one training day no later than six months after completion of the acceptance test.
   b. Structure course to address specific topics that students need to discuss and to answer questions concerning operation of system.
   c. Upon completion, students fully proficient in system operation and have no unanswered questions regarding operation of installed system.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/INSTALLERS

A. Acceptable Manufacturers/Installers:

~~1. Automated Logic by Airco Automation~~

2. Delta Controls by Trinity EMCS

~~3. Alerton by Syzerco~~

~~4. APOGEE system by Siemens Building Technologies.~~

~~5. Johnson Controls by JCI~~

~~6. Unless otherwise noted, installed by manufacturer.~~

~~7. Trane installed by Trane~~

B. Other Manufacturers: Submit substitution request.

2.02 SYSTEM DESCRIPTION

A. General:

1. Provide a complete control system, consisting primarily of electronic direct digital control devices.

2. System consists of modular and distributed microprocessor based control and monitoring units connected together by communications trunks. Capable of global data sharing and communication between controllers.

3. System architecture distributed and not rely on central processing unit (CPU) for sharing point data between controllers, or for control functions requiring data from other controllers.

4. Multipurpose controller(s) consisting of CPU, system program, memory, power supply, and input/output drivers which communicated with terminal equipment controllers through a communications network.

5. Provide operator’s interface.

6. Provide equipment, installation, wiring, and accessories as required but not necessarily specified to accomplish operations as described.

B. Environmental Conditions: The

1. Rate DDC panels and other field equipment for continuous operation under ambient environmental conditions of 35 degrees F to 120 degrees F dry bulb and 10 percent to 95 percent relative humidity, noncondensing.

2. Instrumentation and control elements rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installation.

3. Install control devices in an enclosure suitable for the installed environment.

C. System Accuracy and Display:

1. DDC system to control space temperature with a range of 50 degrees F to 85 degrees F ±1 degrees F for conditioned space (display to nearest 0.5 degrees F); 15 degrees F to 130 degrees F ±1 degrees F for unconditioned space (display to nearest 0.5 degrees F). Return air humidity controlled to 20 percent RH to 35 percent RH ±3 percent RH.

2. DDC system to control duct temperature with a range of 40 degrees F to 140 degrees F ±1 degrees F (display to nearest 0.5 degrees F).

3. Water temperature with a range of 30 degrees F to 100 degrees F ±1 degrees F (display to nearest 0.5 degrees F); the range of 100 degrees F to 300 degrees F ±2 degrees F (display to nearest 0.5 degrees F); and water temperatures for the purpose of performing BTU calculations using differential temperatures to ±0.5 degrees F using matched sensors (display to nearest 0.5 degrees F).

4. Pressure with a range for the specific application ±5 percent of range.

2.03 MATERIALS AND EQUIPMENT

A. Piping:

1. General:
   a. Label tubing with numbers shown on control drawings.
   b. Provide sufficient gauges so that the input and output pressures of each device may be determined at or near its location. Show gauges on control diagram. Provide a gauge at each AO point.
   c. Air Mains: 3/8-inch OD minimum; branch air lines sized 1/4-inch OD minimum. 5/32-inch tubing may be used in multi-tube sheathes only.
   d. Run piping parallel to established lines, installed in neat and professional manner.

2. In Mechanical Rooms and Other Exposed Locations:
   a. Hard drawn copper tubing with soldered fittings, with compression fittings only at control instruments and controlled devices.
   b. At supplier’s option, soft copper or polyethylene tubing may be used in accessible areas, supported in an enclosed gutter or conduit.

3. In concealed locations such as above ceilings and within walls of finished spaces, plenum rated polyethylene tubing may be used.

4. Use Type L hard drawn copper tubing for pneumatically actuated smoke dampers and control devices providing smoke control functions.

B. Duplex Instrument Air Supply Station:

1. Provide supply air to HVAC and plumbing control equipment, including terminal units, fan powered boxes, fans, etc. Include devices in air compressor sizing calculations.

2. Provide a complete standby for both the compressor and dryer. Arrange standby compressor to provide required amount of compressed air whenever system pressure drops below temperature control manufacturer’s recommended operating pressure. Starting of standby compressor completely automatic to provide uninterrupted service. Sufficient capacity to supply the entire building under normal conditions with compressor running at full load not over 33 percent of the time.

3. Provide reciprocating piston type compressors with design life of not less than 20,000 hours elapsed running time before major overhaul is required. Oil lubricated compressors utilizing cylinder lubrication in which oil is directly introduced into compression chambers or in which crankcase fumes are directed into suction inlets will not be permitted. Oil consumption not to exceed three fluid ounces per 100,000 scfm of delivered air. Piston speeds not to exceed 450-feet per minute.

4. Provide each compressor with intake air cleaner, discharge stop valve, and pressure relief valve. Relief valve, placed between compressor and the discharge stop valve, set for pressure of 10 psi above control switch cutout pressure. Cleanable and impingement type intake air cleaners.

5. Each compressor driven by electric motor wound for the current available. Control by pressure operated, enclosed pilot switch connected to motor starter. Pressure switches for start/stop control set to operate between 80 and 100 psi. Equip system with electrical duplex controller, starters, and disconnect switches, thus permitting automatic alternate operation of each system and automatic simultaneous operation upon demands exceeding capacity of either system.

6. Provide each compressor and motor with a cast iron or steel base mounted on air tank or on separate concrete foundation. Provide vibration isolation per Section 23 05 48, Vibration and Seismic Controls of HVAC Piping and Equipment. ASME approved. Size for no more than 12 compressor starts per hour, 33 percent run time.

7. Provide compressor with filtering and air drying system on leaving side. Supply at required rate, air having a dew point of not more than 20 degrees F at 20 psi and having entrained particle size of not more than 5 microns. Self contained air drying system, mechanical refrigeration type using air-cooled condenser.

8. Condensing Unit:
   a. Provide devices for automatic draining of condensed water and oil.
   b. Electrically interlocked through relay or temperature sensing device, so whenever condensing unit fails to operate, it will alarm at the operator's terminal.

9. Moisture Eliminator: Provide before final filter.

10. Alarm: Alarm activated by air pressure failure.

11. Refrigeration Unit Motor:
    a. Suitable for continuous operation at 40 degrees C ambient temperature.
    b. Capacity rated with ambient temperature.
    c. Rated with ambient temperature of not more than 120 degrees F and with minimum suction temperature of 35 degrees F.
    d. In accordance with the Safety Code for Mechanical Refrigeration, USASI-B-9.1.

C. Controls and Power Wiring:

1. General:
   a. Electric equipment and wiring in accordance with Division 26, Electrical.
   b. Manual or automatic control and protective or signal devices required for operation specified, and control wiring required for controls and devices.

2. Wiring:
   a. Field and Subfield Panels:
      1) Voltage in panels not to exceed 120V.

2) Devices wired to higher voltages, mount in suitable individual enclosures or group in separate control panel.
3) Coordinate electrical power supply with Division 26, Electrical.

b. Motor Control Centers: Responsibility for correct voltage of holding coils and starter wiring in pre-wired motor control centers interfacing with automatic controls is included hereunder.
c. Wiring for DDC systems communications buses two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80 degrees C.

3. Communications Links Surge Protection:
   a. Protect communications equipment against surges induced on communications link.
   b. Cables and conductors which serve as communications links to have surge protection circuits installed that meet the requirements of REA PE-60d.

4. Communications Links Overvoltage Protection:
   a. Protect communications equipment against overvoltage on communications link conductors.
   b. Cables and conductors which serve as communications links have overvoltage protection for voltages up to 480 VAC rms, 60 Hz installed.
   c. Instrument fuses or fusible resistors are acceptable for this application.

5. Power Line Surge Protection:
   a. Protect equipment connected to AC circuits from power line surges.
   b. Do not use fuses for surge protection.

D. Control Panels:

1. Provide wall-mounted control panels to contain relays, terminal strips, power supplies and other equipment in building control system.

2. UL listed, minimum NEMA 1, minimum 14 gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch.

E. Section 23 52 00, Heating Boilers:

1. Mount boiler management system (BMS) control panels.

2. Provide and install wiring required for boiler controls.

2.04 CONTROL DEVICES

A. Temperature Instruments:

1. Room Temperature Sensors: Platinum RTD type with accuracy of ±0.4 degrees F at 70 degrees F; operating range 30 to120 degrees F; linear to DDC system; single point sensing element in wall-mounted ventilated enclosure with insulating backplate if mounted on exterior wall.
   a. Sensor not to have digital readout display.
   b. Sensor has user adjustment based on DDC programmed offset.

2. Duct Temperature Sensors: Platinum RTD element with accuracy of ±0.5 degrees F at 32 degrees F, averaging type consisting of array of single point sensing elements, securely mounted in duct or plenum; operating range 0 to 100 degrees F; linear signal; 20-foot element.

3. Outside Air Temperature Sensor: Platinum RTD element with accuracy of ±0.5 degrees F at 32 degrees F; Range -60 to 100 degrees F, single element, linear, with weather and sun shield for exterior mounting.

4. Low Temperature Limit Thermostat: Minimum 20-foot capillary sensing element, triggering on low temperature as sensed by any 6-inch segment; snap acting, normally open contacts, manual reset, line voltage.

5. Liquid Immersion Temperature Sensor: Platinum RTD element, with accuracy of ±0.5 degrees F at 32 degrees F, stainless steel well and assembly, range 40 to 240 degrees F.

6. Pneumatic Room Thermostat: Two-pipe relay type with concealed adjustment, and no thermometer, blank cover secured with Allen screws.

B. Humidity Instruments:

1. Space Humidity Sensors: Operating range 10 to 95 percent relative humidity, accuracy ±5 percent, surface mounted ventilated enclosure for wall mounting.
   a. Sensor to not have digital readout display.
   b. Sensor to have user adjustment based on DDC programmed offset.

2. Duct Humidity Transmitter: Capacitive type sensor and transmitter, linear output signal, automatic temperature compensating, air filter, ±2 percent RH accuracy from 0 to 100 percent RH, industrial quality.

C. Motorized Control Dampers:

1. Multi-blade air foil type, except where either dimension is less than 10 inches a single blade may be used. Maximum blade length to be 48 inches. Provide parallel blades for positive or modulating mixing service and opposed blades for throttling service. Blades to be interlocking, minimum 16 gauge galvanized steel.

2. Compression type edge seals and side seating stops. Reinforced damper blades have continuous full-length axle shafts, axle to axle linkage, and/or operating jackshafts as required to provide coordinated tracking of blades. Over 25 SF in area to be in two or more sections, with interconnected blades. Maximum air leakage of 3 cfm per square foot at 1-inch wg pressure. Provide automatic dampers except those specified to be provided with units. Tested in accordance with AMCA Standard 500. Based on Ruskin CD-60.

D. Motorized Valves:

1. Equip with equal percentage with tight shutoff. Two position valves line size (full port two position ball valves), modulating water valves sized at 5 psi drop or as shown on the Drawing.

2. Screwed ends except 2-1/2-inch and larger valves with flanged ends.

3. Select valves to modulate smoothly at system pressures and flows.

4. Select valves with close-off ratings and spring ranges designed to operate at the maximum flows and maximum available pump heads scheduled without leakage.

5. Bubble tight butterfly valves acceptable on 2-1/2-inch lines and above for two-position action only.

6. Air handling unit heating and cooling coil valves sized for 5 psi drop, unless otherwise noted on drawings.

E. Valve and Damper Operators:

1. Electronic modulating actuators with low voltage DC or current positioning signal.

2. Each actuator have the current limiting circuitry incorporated in its design to prevent damage to the actuator.

3. Provide modulating actuators and accept 0-10 VDC or 2-10 VDC or 4-20 mA input signal.

4. Actuators provide the minimum torque required for proper close-off against the system pressure for the required application.

5. Spring return feature permits normally open or normally closed positions of the valve or damper.

6. Direct shaft mount rotational actuators have external adjustable stops to limit the travel in either direction.

7. Actuators powered by 24 VAC.

F. Flow Switches:

1. Provide McDonnell Miller or approved equal.

2. Install in piping in such a manner so as to eliminate nuisance fluttering.

3. Provide time delay relays where required to eliminate false alarms when equipment is started.

4. Differential pressure type.

5. Current switches set for pump or fan normal current ranges are acceptable.

G. Electric Solenoid Operated Pneumatic (EP) Valve:

1. EP valves have three part operation -- common, normally open, and normally closed. EP valves.

2. Rated for 25 psig when used in control system operation at 20 psig or less or rated at 150 psig when used in control system operation from 25 to 100 psig.

H. Differential Pressure Switch:

1. Required for proof of flow on fans and pumps.

2. Setpoint adjustable with operating range of 0.5 to 12-inches W.G. for fans, and 5 to 30-feet wc for pumps.

3. Close when set pressure differential is met or exceeded.

I. Differential Pressure Transducer:

1. Provides value of pressure drop across filter bank through DDC system.

2. Operating range 0 to 2-inches wc, linear, accurate to ±2.5 percent of span.

J. Duct Static Pressure Transmitter:

1. Operating range 0 to 5-inches wc for duct mounted transmitter and 0 to 5-inches wc for fan high limit transmitters.

2. Sensors either diaphragm or rigid element bellows, electronic type.

3. Provide transmitter with stop cock and tubing for attacking portable pressure gauge.

4. Sensing tube securely mounted in duct with appropriate fitting.

5. Accuracy ±1 percent of span, maximum response time 1 second.

K. Current Transformer:

1. Current status switch, adjustable setpoint 1-135A, ±1 percent of range, capable of monitoring motor's status and detection of belt breaking or slipping.

2. Hawkeye 700, or approved equal.

L. Building Static Pressure Transmitter:

1. Operating range of -0.1 to 0.1-inches wc, linear to DDC system.

2. Sensing tubes located inside and outside building use shielding and/or surge tanks to minimize effects of wind.

3. Accuracy ±1 percent of span.

M. Piping Pressure Transmitter:

1. Operating range 0 to 50 psig, linear to DDC.

2. Provide threadolet for mounting to pipe installed by others .

3. Accuracy ±1 percent of range.

N. Products of Combustion Detectors: Duct smoke detectors are provided under Division 28, Electronic Safety and Security with single set of SPDT auxiliary contacts for control contractor connection.

O. Emergency Stop Switch: Red, mushroom type, pull out to operate.

P. End Switches: Turret head type SPDT. Square D Class 9007, Type C54B2, or equal.

Q. VAV Actuators:

1. Proportional 24 VAC actuators using a 4 to 20 mA range of control signals.

2. Automatically stop at end of travel and include a permanently lubricated gear train.

3. Furnished by the controls manufacturer and factory installed and tested by the terminal unit manufacturer.

R. Carbon Dioxide Sensor:

1. Infrared sensing, Carbon Dioxide gas monitor. Based on Airtest TR9290 series.

2. Detection Range: 0-2000 ppm

3. Accuracy: +/- 3 percent of measured value

4. Response Time: 2 minutes

5. Outputs: 0-10V, 4-20 mA

6. Calibration: Self-calibrating, calibration not required

7. Power Requirement: 24 VAC/VDC ±20 percent, 50-60Hz (half-wave rectified)

8. Operating Temperature Range: 32 degrees F to 122 degrees F

9. Operating Humidity Range: 0 percent - 95 percent RH, Non-Condensing

10. Display: Sensor [be provided] [not be provided] with digital display.

S. Water and Steam Flow Meters:

1. Provide Vortex flow meter that provides output signals, which are linear with the flow rate.

2. Accuracy +/-1 percent of measurement for volumetric flow rates greater than 5 percent of specified maximum flow rate for each building.

3. Flowmeters provide specified accuracy when installed and configured for upstream minimum straight runs of 24 inches.

4. Vortex flow meters will be Intelligent microprocessor-based, with integral LCD digital Display/Configurator allowing complete commissioning and operation without external programming devices.

5. Meter design will permit maintenance and repair of flow sensor and electronics without removing the meter from line or shutting down steam flow.

6. Flowmeter: Turn down ration of 50:1 or higher.

7. Meter have ANSI 150 flanged end connections, wafer style not acceptable.

8. Flange size of the adjoining pipe the same nominal size as the flow meter.

9. Mount flow meter in a straight, unobstructed pipe with a minimum of 10 pipe diameters upstream of the meter and 5 pipe diameters downstream, compensating for any induced flow effects according to manufacturer’s recommendations.
   a. Maximum Operating Pressure: 400 psi
   b. Output Signal: Analog 4-20mA signal

c. Supply Voltage: 24VDC
d. Interrogation: FoxCom version
e. Based on: FoxBoro I/A Series Intelligent Vortex Flow Meter 83

T. Water Flow Meters: Provide insertion electromagnetic flow meters.

1. Accuracy: ± 1 percent of reading from 0.25-20 ft/sec

2. Liquid Temperature Range: 15-300 degrees F

3. Maximum Operating Pressure: 400 psi

4. Output Signal: Analog 4-20mA signal

5. Pipe Size Range: Minimum 3-inch

6. Installation: 15 pipe diameters up and 5 pipe diameters down, or manufactures recommendations

7. Display: Sensor [be provided] [not be provided] with digital display. [Provide BTU meter Onicon system 10]

8. Based On: Onicon F-3500

U. Natural Gas Sub-Meter

1. Electromagnetic flow meter, insertion type.
   a. Accuracy: ±1 percent of reading from 500-7000 SFPM
   b. Output Signal: Analog 4-20 mA signal
   c. Display: Digital
   d. Based On: Onicon F-5100

V. Airflow Stations:

1. Air Flow Station (Duct Mounted):
   a. Acceptable Manufacturers:
      1) Ebtron
      2) Kurz
   b. General: Electronic air measuring system consisting of thermistor based sensor grid and microprocessor based electronics.
   c. Sensor Probes: Thermistors probes and linear ICs, aluminum casing, duct mounted, wiring Teflon or kynar coated and encased, 20 degrees F to 160 degrees F operating range, weather resistant finish, flanged welded aluminum frame.
   d. Microprocessor and Electronics: Solid state microprocessor, permanent non-volatile memory, regulated power supply, software based system, 0-5 vdc, 0-10 vdc, or 4-20 mA signals, linear flow and temperature outputs, line surge and transient protection.
   e. Performance:
      1) ±2 percent, +20 fpm across total calibrated range of 0 to 5000 fpm, for duct mounted, 0-10,000 fpm for fan inlet mounted, repeatability better than ±0.4 percent of reading.
      2) Pressure drop not tp exceed 0.005-inch wg at 2000 fpm.
   f. Based On: Ebtron-Duct mounted XP000 series.

2. Air Flow Station (Fan Inlet):
   a. Acceptable Manufacturers:
      1) Ebtron
      2) Air Monitor
      3) Paragon
      4) Pace
      5) Or approved equal.
   b. Fan inlet airflow traverse probe, multiple total and static pressure sensors place at concentric area centers along exterior surface of cylindrical probe, internally connected to averaging manifolds.
   c. Dual end support swivel brackets suitable for mounting in fan inlet bell, aluminum construction, hard anodized finish.
   d. Probes capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors with an accuracy of 3 percent of actual flow over a fan operating range of 6 to 1 capacity turndown.
   e. Based On: Fan Inlet XF000 series.

3. Automatic Air Flow Station Measuring Damper:
   a. Acceptable Manufacturers:
      1) Ruskin IAQ50X
      2) Greenheck AMD-42
      3) Tamco/Ebtron Air-IQ
      4) Or approved equal.
   b. Description: Automatic control damper with integral electronic airflow measuring system.
   c. Dampers:
      1) Multi-blade, airfoil type, extruded aluminum.
      2) Full-length axle shafts.
      3) Damper blades operate in unison.
      4) Dampers exceeding 25 SF in area in two or more sections.
      5) Assembled depth not to exceed 18 inches.
      6) Leakage rating not to exceed 4 cfm/sf at 1-inch static pressure when tested in accordance with AMCA Standard 500D.
   d. Damper Actuator:
      1) 24 VAC electric modulating.
   e. Air Flow Measurement Assembly: Includes airflow measuring station, controller, and associated tubing and connections.
      1) Measuring Range: 300 fpm to 2,000 fpm velocity.
      2) Accuracy: ±5 percent of reading.
      3) Solid state microprocessor.
      4) Linear flow output.
      5) Line surge and transient protection.
      6) Input Signal: 0-10 VDC.
      7) Output Signal: 0-10 VDC.

W. Airflow Transmitters:

1. Provide transmitter with 4-20 mA output signal, accurate to ±0.25 percent for full range, range selected based on the actual flow element and expected velocity pressure, and linear output on velocity turndown of 10 to 1. Setra Model C264.

2. Provide a calibration certificate for each unit.

X. Window Switch: Magnetic contact switch.

1. Acceptable Manufacturers:
   a. Sentrol
   b. GE Security
   c. Other Manufacturers: Submit substitution request

2. Magnetic type contact switch, flush mount, concealed within window frame.

3. Switch provides input to Building Management System on status of window (open/closed).

Y. Leak Detection System:

1. Provide complete system including alarm module with audible alarm and contacts for connection to building DDC control system, sensing cable, leader cable, jumper cables, end terminations, hold-down clamps and other required accessories.

2. Tracetek by Tyco Thermal Controls, or equal.

2.05 DDC FIELD PANELS

A. Multipurpose Controllers:

1. Stand-alone microprocessor based panels, enclosed in sturdy metal enclosure with two standard RS232 interface ports, network communications module, power supply, and battery back-up.

2. Panels will be used to connect field sensors and control devices. Fully supervised to detect failures. Construct panel so that functions are implemented on replaceable circuit boards to permit field maintenance. Panels completely field programmable through portable terminal. Minimum 8-hour battery backup system.

3. Link panels with data trunk cable to other controllers and Operator's Terminals to distribute information. Field panels continuously exchange data through trunk cable without requiring output to input wiring between panels. Arrange system so operations are maintained without the central computer being connected to the system.

4. Upon failure of the DDC field panel, including transmission failure, the panel automatically forces the controls to remain in the last command status.

5. Provide a real time clock with calendar maintaining seconds, minutes, hours, and days of the week, accurate to ±10 seconds per day.

6. Provide sufficient memory to perform specified and shown DDC field panel functions and operations, including spares. Each DDC panel to have 10 percent minimum spare memory board spacing.

7. DDC field panel contain hardware to support power fail automatic restart.

8. Provide locking type mounting cabinets with common keying.

9. DDC field panel have built-in diagnostics to display to operator interface terminal any sensor transmitting signal out of its design range.

10. Control logic done with software resident in each local DDC panel. Auxiliary relays may be used only when required for load contact rating.

11. Panels UL listed.

B. Terminal Equipment Controller:

1. Provide for each piece of equipment, as specified. Include point inputs and outputs as necessary to perform specified control sequences.

2. Each controller performing space temperature control provided with a matching room temperature sensor. Include terminal jack to monitor hardware and software associated with controller.

3. Include setpoint adjustment dial, temperature indicator, and override switch for each sensor.

4. Override Switch:
   a. Override night setback mode to normal (day) mode when activated by occupant.
   b. Adjustment dial and override switch may be locked out, overridden, or limited through software from central work station or portable terminal.

5. Independent of other network communications. Receive real time data from central work station or multipurpose controller.

6. Proportional, integral, and derivative (PID) algorithms field adjustable.

7. Data base and sequence of operation programs stored in non-volatile EEPROM and EPROM.

8. Controllers networked through communications link to the multipurpose controller.

9. Power controllers from 24 VAC source. Provide dedicated power source. Coordinate with Division 26, Electrical

10. VAV box controllers include differential pressure transducer connected to manufacturers standard velocity sensor, and include provisions for both automatic and manual calibration of transducer to ensure against drift. Incorporate algorithm to allow for modulation of hot water heating valve, and supplementary hot water radiation valve. Fan-powered terminal units control series or parallel fan as appropriate. Provide fan status proof current switch.

2.06 CONNECTION TO EXISTING NETWORK

A. General: Communication between peer-to-peer DDC control panels via TCP/IP over the existing Ethernet system.

B. Provide software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing paging system.

2.07 BACNET COMPATIBILITY

A. DDC System and components BACnet Data Communications Protocol compliant.

B. System fully integrated and installed as a complete package of BACnet compliant controls and instrumentation.

C. Capable of seamless BACnet integration with existing BACnet compliant devices as well as future BACnet compliant devices.

D. No portals or third party devices required for integration with existing or future equipment.

E. Devices utilized in the BACnet interface BACnet Testing Laboratories (BTL) listed and labeled.

2.08 OPERATOR INTERFACE SYSTEM

A. Operator Workstation:

1. Provide personal computer that performs data access, operator's commands, alarm management, requests for reports, file generation, diagnostics, and modifications. Control system not dependent on Operator Workstation for operation. Computer to be used for operator interface.
   a. CPU: Windows compatible computer using current microprocessor technology operating at minimum of 2.8 GHz with 512 MB RAM.
   b. Display Unit: Minimum 17-inch (nominal) flat screen color monitor, supporting a minimum display resolution of 1280x1024 pixels, with separate controls for color contrast and brightness, and non-reflective screen.
   c. Video Card: Minimum 64 MB RAM capable of supporting a minimum of 1280x1024 resolution with a minimum of 32 Bit color.
   d. Drives: Minimum 120 G byte hard disc, CD Read/Write, DVD player.
   e. Alphanumeric Keyboard and Mouse: Provide an alphanumeric keyboard with standard 96 character ASCII set output. Provide a "mouse" input device with pad.
   f. Printers: System printers are to be of the color ink jet type operating under software control as specified in the software section of this specification.
   g. Operating System: Windows XP, 2000 or comparable.

B. Web-Based Access:

1. Provide a web-based controls interface with at least 3 user login accounts and password each with the capability of different access privileges that performs data access, operator's commands, alarm notification, requests for reports, file generation, diagnostics, and modifications.

2. Controls accessible in mechanical room by direct connection from a laptop to a data port.

3. Provide a temporary computer located on-site in the mechanical room until the commissioning, testing, and balancing has been completed.

4. Proovide a temporary computer located on-site in the mechanical room, with software and capabilities necessary to support commissioning, testing, and balancing and other activities required for project completion.

C. Graphics: Provide a complete graphics package with the following features:

1. Provide separate schematic diagram depicting each system. Diagrams to show major components such as fans, dampers, heating and cooling coils, humidifiers, pumps, heat exchangers, chillers, boilers, towers, ductwork, piping, etc., arranged to convey to viewer system configuration and flow of each system.

2. Provide plot plan, riser plan, and selected floor plans of buildings with the location of each mechanical room and major equipment location indicated.

3. Provide symbols superimposed on each schematic to indicate each control device including control valves, damper motors, temperature sensors, pressure sensors, etc. Provide real time dynamic displays of the temperature, humidity, pressure, flow rate, run status, alarm status, and etc., adjacent to each control symbol. Arrange CPU to update each displayed analog and digital value minimum of every 15 seconds.

4. Provide indication of setpoints, with each setpoint value located adjacent to each sensed value.

5. Provide means to allow the user to easily change or add graphics via computer assisted drawing function utilizing freehand mouse.

6. Provide means to allow user to transfer repeated system schematics and symbols between graphics without redrawing them. Provide symbol library arranged to store commonly used symbols.

7. Provide a telescoping or zoom program to allow use to move from plot plan to mechanical room plan to system graphic to control device display by simply clicking the mouse.

8. Provide dual function windowing program to allow user to view a split screen and toggle between simultaneous operations.

D. Trend Data Collection and Historical Data:

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. System point may be trended automatically at time-intervals, time-synchronized intervals, change of value, or by event user-definable.

2. Collect and store trend data on hard disk for future diagnostics and reporting. Automatic trend collection may be scheduled of zones, events, and reports. Archive to network drives or removable disk media for future retrieval.

3. Allow the user to view trended point data. Display data in both tabular and graphical format. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred online to Microsoft Excel.

4. Provide the following trend data for review by the commissioning agent:
   a. Adequate trending data maintained to evaluate system performance and diagnose system problems. Controls Contractor is responsible for trending points necessary to evaluate controlled equipment. Controls Contractor to coordinate with the Cx regarding trend intervals and specific points to be trended. The following systems trended and trend data provided for review by the engineer and commissioning agent at 15-minute intervals unless otherwise directed.
   b. Building electrical, natural gas, domestic water, heating water flow.
   c. Monitored temperatures including but not limited to space, supply, return, outside air, mixed air, chilled water, heating water, steam, pumped condensate, and etc.
   d. Occupancy modes as they apply to each piece of controlled equipment including but not limited to optimal start, occupied, unoccupied, temporarily occupied (override, etc.), night low limit, night high limit, night purge.
   e. Motor run commands and motor proofs for fans and pumps.

f. VFD Speeds for controlled equipment.
g. Measured airflows for both air handlers and volume control units.
h. Damper positions for both air handlers and volume control units.
i. Heating and cooling valve positions.
j. Occupancy sensor indications used for HVAC control.
k. Set points including but not limited to occupied and unoccupied space temperature, supply air temperature, hydronic supply temperature, radiant heating and cooling temperature, pumping pressure, fan static pressure, etc.
l. Supporting information necessary to evaluate setpoint reset sequences.
m. Operating schedules for controlled equipment.
n. Loop tuning variables.

2.09 APPLICATION PROGRAMS

A. General: Provide user-programmable DDC system programs with library of base-level predefined functions with user specified parameters.

B. Time of Day Scheduling:

1. Six schedules for equipment operation.

2. Seven unique days per schedule.

3. Program individual time cycle capability for each piece of equipment.

C. Control Priorities:

1. Provide an effective order of control priorities such that each succeeding level of optimization does not interfere with a more critical function. Alarm actions and manual commands from the operator to override lower level functions (such as duty cycling or scheduling).

2. Events, initiated outside the DDC system causing equipment shutdown automatically reset when events causing the shutdown is cleared, such as power failure or fire alarm. (when fire alarm system is cleared and reset, air handlers, etc., sequentially restart).

3. Alarms within the control system (such as freeze protection), mechanical equipment (such as air handlers) restart after the alarm condition is manually reset.

D. Alarms: Provide the following alarm processing capabilities:

1. Connected status or analog point may be designated as alarm input point.

2. Start/stop points with status feedback as well as associated analog alarms have a user-programmable inhibit time assigned to each point to prevent nuisance alarms from occurring during startup of HVAC equipment.

3. Each alarmable point have change-of-state priority assignment assignable at 3 levels. One each for its level of criticality.
   a. Low : Maintenance alarms
   b. High: Critical HVAC equipment alarms
   c. Emergency: Life safety alarms.

4. User may designate which conditions of alarm cause alarms to be initiated for display. The user may also designate alarm message for alarm condition and for return to normal condition as desired. Each message may be up to 32 characters in length and up to 32 messages are available in each digital management system.

5. Provide for orderly display of alarms based on criticality (i.e., if two or more alarms occur simultaneously); alarm with highest level of priority displayed first.

6. User may designate which conditions of alarm cause alarms to be initiated for display. User may also designate alarm message for alarm condition and for return to normal condition as desired. Each message may be up to 80 characters in length.

7. Provide automatic phone dialing feature with the capability to report a general alarm recorded message.

E. Security: Support multi-level password access with the following minimum access levels:

1. Read-only level, without capability of changing any part of software.

2. Adjustment level, allowing operator to adjust setpoints and schedules, force outputs on/off, but not to modify programming.

3. Full programming access.

4. Supports additional levels of programming access.

F. Power Failure: In the event of the loss of normal power, orderly shutdown of controllers to prevent the loss of database or operating system software. Non-volatile memory incorporated for critical controller configuration data, and battery backup provided to support the real-time clock and volatile memory for a minimum of 72 hours.

1. During a loss of normal power, the control sequences go to the normal system shutdown conditions.

2. Upon restoration of normal power and after a minimum off-time delay, the controller automatically resumes full operation without manual intervention through a normal soft-start sequence.

3. Should a controller memory be lost for any reason, the operator workstation automatically reloads the program without intervention by the system operators.

G. Providing load shedding software package.

H. Preventive maintenance software package.

2.10 INPUT/OUTPUT (I/O) FUNCTIONS

A. Analog Inputs (AI):

1. Monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation.

2. Provide signal conditioning for each analog input.

3. Individually calibrate analog inputs for zero and span, in hardware or in software.

4. Minimum 12 bit A to D resolution.

B. Analog Outputs (AO):

1. Accept digital data, perform D-to-A conversion, and output a signal compatible with the operator.

2. Individually calibrate analog outputs for zero and span.

3. Provide short circuit protection.

4. Minimum 8 bit D to A resolution.

C. Digital Inputs (DI):

1. Accept ON/OFF, OPEN/CLOSE or other change of state (two-state data) indications.

2. Provide isolation and protection against input voltage up to 180 Vac peak.

D. Digital Outputs (DO):

1. Provide contact closures for momentary and maintained operation of output devices.

2. Closures have a minimum duration of 0.1 second.

2.11 UNINTERRUPTABLE POWER SUPPLY

A. General:

1. Provide an uninterruptable power supply (UPS) for each DDC field panel.

2. UPS fed by 120V AC emergency power circuits.

3. Floor or wall mountable.

B. Provide MGE Pulsar UPS or pre-bid approved equal.

C. UL 1778 listing.

D. Base sizing on peak current requirements of connected load plus 15 percent factor of safety

E. Provide manufacturer's standard three-year comprehensive warranty, including batteries.

2.12 ENERGY MANAGEMENT SYSTEM

A. General

1. Provide a complete system consisting of metering instruments, communications between components; communications network; dataloggers; protocol converters and other appurtenances as required for a complete system.

2. Meters, network controllers, and Ethernet gateways provided with non-volatile flash memory sufficient to maintain system programming indefinitely.

B. Data Acquisition Network

1. Connect meters to DDC system via TCP/IP communications over ethernet LAN. Communications in BACnet/IP protocol.

2. The system may utilize Modbus for communication with field devices over local RS-485 communications links.

3. Connection to the building Ethernet network made at the nearest wall data outlet in a mechanical or electrical room.

4. Limit cabling lengths between devices in accordance with manufacturers published requirements.

C. Data Access and Display

1. Measured values, both instantaneous readings and historical data, available to any user on any computer with an Internet connection without requiring a specific operating system or proprietary software that is not publically available freeware.

2. Assign metering a unique network address and by entering that address or corresponding URL into a web browser, HTML web pages of data available for that device.

3. Specific browser software permitted to be required to access system features beyond the measured values.

D. Data Format

1. Synchronize to a single time base so that events on the system can be compared at different locations on the system using a common time base. Time base synchronized with DDC system.

2. Store data in DDC system database.

E. Software

1. Seamless BACnet/IP integrated with building Direct Digital Control, DDC system, and have the ability to display individual meter output data.

2. Calculation engine to virtually calculate, display, and store-derived values.

3. Download meter data every 15 minutes.

F. Interface and Display

1. Provide 32-inch LED flat panel display.

2. Scroll through display features in 20 second intervals (adjustable).

3. Display:
   a. Monthly Utility Total Energy (kbtu) and EUI (kbtu/sf/yr) bar chart overlaid with the prior year by month. Use different colors to indicate the contribution of gas and electricity to each monthly total bar.

b. Monthly System Total Energy (kbtu) and EUI (kbtu/sf/yr) bar chart overlaid with the prior year by month. Use different colors to indicate the contribution of each end use (Mechanical, plug loads, plumbing, and lighting) to each monthly total bar.
c. Current Day's end use energy demand (kW) overlaid with the annual weekday and weekend average demand (kW), and temperature in a line chart. Provide separate slides for Lighting and Plug Load end uses.
d. Current Day's end use energy demand (kbtu/hr) overlaid with the annual weekday and weekend average demand (kbtu/hr), and temperature in a line chart. Provide separate slides for Mechanical and Plumbing Load end uses.
e. Energy Meter Gauge indicating real-time end use energy demand (kW and W/sf) for Lighting and Plug Loads.
f. Energy use pie chart indicating percent of annual energy from each endues (Mechanical, Plumbing, Plug Loads and Lighting).
g. Monthly water usage (gallons) and WUI (gallons/person/year) bar chart overlaid with the prior year by month.

G. Current Sensors and Transformers

1. Current Transformers, 5A:
   a. Submetering:
      1) Accuracy: 1.0 percent (10 percent-100 percent of Current Transformer rating).
      2) Split-core: Flex-core, Hawkeye, Square-D, Veris.

2. Current Sensors; 0-5 VDC, 330 milli-volt:
   a. Submetering:
      1) Accuracy: 1.0 percent (10 percent-100 percent of Current Transformer rating).
      2) Manufacturers: Square-D, Magnelab, Veris, Sentron.

H. Electrical Energy Meters

1. Measured values: Real kWH, Reactive kVARh, Apparent kVAh, kW, power factor, RMS power and current per phase.

2. Voltage: monitored circuit voltage indicated in documents.

3. Current Transformers: Provide milli-volt compatible meters where milli-volt Current Transformers are used.

4. Minimum Current Transformer input amperage (5 Amp Current Transformer only): 10A.

5. Sampling rate: minimum 3kHz.

6. Submetering Meter Accuracy: +/-1 percent accuracy (10 percent to 100 percent of Current Transformer rating).

7. Manufacturers: Veris E50, Siemens, Square D.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Operator Workstation: Locate as shown or submit proposed location where not shown.

B. Mounting Panels: Locate panels where shown on Drawings or near item of equipment to be controlled, but not on equipment itself.

C. DDC Field Panels:

1. Provide number of panels required to accommodate DI, DO, AI, and AO points and hardware and software to accomplish specified control sequenced.

2. Locate panels in mechanical or electrical rooms

3. Submit proposed locations for approval prior to preparing control drawings.

D. Pneumatic Signals: The use of pneumatic signals to start and stop motors is not allowed.

E. Electrical:

1. Provide control wiring for control devices and control panels.

2. Run control wiring in mechanical rooms or locations susceptible to damage in conduit. Plenum rated cable may be used in other locations.

3. Provide power wiring for control devices and control panels. Utilize designated circuits in electrical power panels. Refer to Electrical Drawings. If no circuits are designated for DDC Controls, submit detailed request for use of spare circuits at no additional cost.

4. Install power wiring in conduit.

5. Grounding: Instrumentation and communication grounding installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

6. Control voltage limited to maximum of 120V.

7. Where relay coil is connected to load side of motor starter to energize with motor operation, external control circuit properly fused with fuse block located in respective starter enclosure.

8. Where relays are used to control single-phase motors directly, provide contacts rated for not less than horsepower rating of largest motor switched by relay.

F. Identification: Provide engraved nameplates identifying switches, lights and starters, and each control device where control function is not readily apparent.

G. Room Thermostats and Room Sensors

1. Wall Thermostats and Room Sensors with User Adjustment: Mount at height of 48 inches above finished floor.

2. Wall Thermostats and Room Sensors without User Adjustment: Mount at height of 60 inches above finished floor.

3. Provide insulating back on thermostats mounted on exterior walls.

4. Provide one thermostat for each zone of temperature control.

5. Submit proposed locations for approval prior to preparing control drawings, where not shown or alternate location is proposed.

H. Carbon Dioxide Sensor

1. Mount sensor at 5 feet above finished floor or as indicated on the plans.

2. Provide sensor quantity as indicated on plans or as required by sensor coverage rating (max. 20-foot radius).

3. Alarm above 850 ppm.

4. Refer to sequence of operations for more information on sensor use.

I. Airflow Station (Duct-Mounted):

1. Install grid array in ductwork according to manufacturer's recommendations.

2. Provide gasket between frame and duct.

J. Airflow Station (Fan Inlet): Install in fan inlet bell in accordance with the manufacturer's instructions.

K. Automatic Air Flow Station Measuring Damper: Install in accordance with the manufacturer's recommendations.

L. Leak Detection System: Refer to Drawings for required locations and extent of area to be covered. Install in accordance with the manufacturer's instructions.

M. Window Switch:

1. Installation of window switches in accordance with window manufacturer's requirements and not to void window warranty.

2. Provide necessary components for a complete installation.

3. Coordinate with window manufacturer for factory or field installation of components.

4. Align magnet with proximity switch.

5. Coordinate installation with Architect and other trades.

3.02 ENERGY METERS

A. Configure system wiring so metering instrument can be isolated and removed from the system without the need to de-energize any power or protective circuit. This requirement may be met in one of two ways:

1. Connections to the metering instrument may be made using separable terminal blocks.

2. Terminal Blocks:
   a. Short the Current Transformer circuit prior to breaking the metering instrument circuit on removal and make the metering instrument circuit prior to unshorting the current transformer circuit on insertion.

b. Transformer and line voltage terminals finger safe when left disconnected and energized.

3. Connections to the metering instrument may be made through test blocks with disconnecting switches for line and neutral voltage circuits and shorting switches for current transformer circuits.

B. System wiring within switchgear of switchboard assembly type SIS, termination of In accordance with manufacturer's published requirements.

C. Provide overcurrent protection for metering equipment based on manufacturer's guidelines and the available fault current at the measurement point. This requirement may be met in one of three ways:

1. Meter within 30 feet of Current Transformers:
   a. Provide meter housing with integral fusing.
   b. Provide circuit breaker or fused disconnecting means adjacent to equipment monitored.
   c. Provide PT with integral fusing.

2. Meter over 30 feet from Current Transformers:
   a. Provide circuit breaker disconnect at equipment location for meter point and individual conductor fusing at meter equipment location.

D. Provide Current Transformers sized based on minimum circuit ampacity listed on equipment nameplate or circuit overcurrent protection device rating.

E. Provide Current Transformer conductors sized per manufacturer's published requirements based on length of run.

F. NEMA 1 housing unless noted otherwise. Meters located in a rooftop or exterior environment NEMA 3R housing.

G. Provide additional NEMA enclosures as necessary for Current Transformers in order to provide manufacturer recommended clearances between separate Current Transformers.

H. Calibrate instrumentation based on National Institute of Standards and Technology, NIST, procedures.

END OF SECTION

SPECIFICATIONS

Creation Date:
4/3/2017

Internal Use Only:

Shop :

W.O. :

***REVISION HISTORY* :**
#1 - 4/6/2017 - Per calcs (sheet 6)

***GLAZING DESCRIPTION* :**
Insulated Glass: Tinted Tempered over Lami w/ Solarban 60 Low-E
** PROVIDE GLASS COLOR TINT **

***METAL FRAME FINISH* :**
Standard 2-Coat Kynar

***TYPE OF ASSEMBLY / SHIPPING* :**
Ship frame assembled and unglazed. Glass to be shipped in separate crate.

***INSTALLATION* :**
By Others

***QUANTITY OF UNITS* :**
Total One (1) Custom Skylight.

***ADDITIONAL NOTES* :**

***GENERAL NOTES* :**

For all skylight support openings: plan dimensions and vertical dimensions shall be held to a ±1/4" non-cumulative tolerance to allow for proper mounting of the aluminum framing systems.

Elevations shall be held to a ±1/4" tolerance to allow for proper mounting of the aluminum framing systems.

The aluminum framing systems shall be manufactured and installed per the approved design drawings. According to the minimum field dimensions present, this system shall be plumb, square and aligned within itself. Any field variation shall be taken up through a variable gap between perimeter members and adjacent structural framework, not through misalignment of the aluminum framing systems.

All welding shall be of standard commercial quality, that is, welds are not ground and/or polished. *All aluminum that shall come in contact with dissimilar materials shall receive, by others, one coat of asphalt emulsion paint, field applied mastic, or other means of separation material.*

Approvals must include field verification of a completed opening and all structural support or a written guarantee of all dimensions and support conditions per drawings prior to any fabrication. Prior to production the customer is responsible for contacting the local AHJ (Authority Having Jurisdiction) regarding permits and local code compliance.

ALL STRUCTURAL SUPPORTS (SILL, WALLS, BLOCKING, ETC.) SHALL BE DESIGNED FOR THE LOADS IMPOSED BY THE SKYLIGHTS. THE STRENGTH, INTEGRITY, AND ACCURACY OF THE SUPPORTING STRUCTURE ARE THE RESPONSIBILITY OF OTHERS.

***ALUMINUM* :**
All extruded aluminum shall be 6063-T6 alloy and temper. All sheet aluminum to be 5005 or 5052 alloy.

***SEALANT* :**
All sealant shall be in accordance with manufacturers' standard instructions. See details for sealant applications. Sealant shall be G.E. 2000 Series 'Silpruf' silicone sealant.

***FASTENERS* :**
All fasteners shall be stainless steel unless noted otherwise. All exposed fasteners will be provided in a finish to match the aluminum frames. All other fasteners will be provided in their natural mill finish.

Kingspan Light + Air
401 E. Goetz Avenue
Santa Ana CA 92707
Tel 714.540.8950
Fax 714.545.2364
Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates

PROJECT : College of Marin

JOB NO: Q1703001 | REV: ----

SHOP: | W.O.:

SHEET: 2 of 11

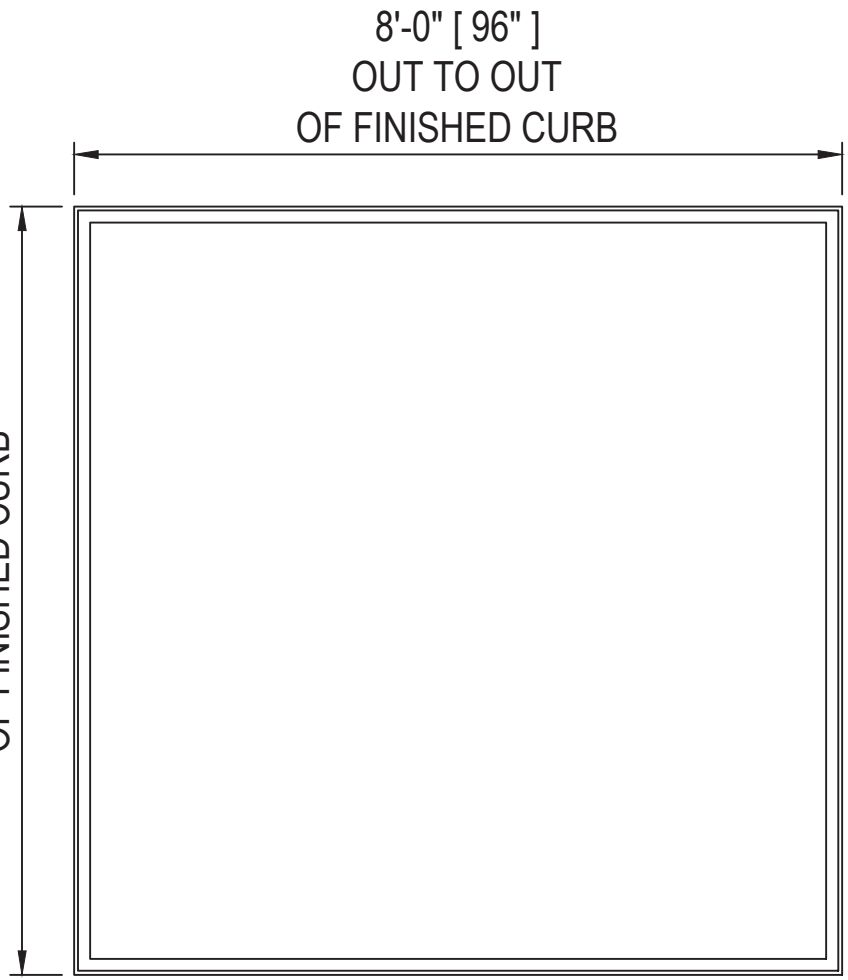
Q1703001-REV1.DWG

brick.

- [x] reviewed with no exceptions
- [ ] rejected
- [ ] revise as noted
- [ ] revise and resubmit
- [ ] submit specified item
- [ ] not reviewed

Submittal was reviewed for general conformance to the design intent only. The Contractor is responsible for confirming and correlating dimensions at the job sites for tolerances, clearances, quantities, fabrication processes and techniques of construction, and coordination of work with other trades.

reviewed by MATTISON LY date 17.06.20



Contractor Submittal Review

Reviewed only for general compliance with the contract documents. Contractor is responsible for: correctness of all quantities and dimensions which shall be confirmed and correlated on the job site, fabrication process and techniques of construction, coordination of all work with that of various trades and the satisfactory performance of all work.

[X] REVIEWED [ ] MAKE CORRECTIONS NOTED
[ ] REJECTED [ ] REVISE & RESUBMIT

IDA Structural Engineers, Inc.

By: msekel Date: 08/30/2017

REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

CUSTOMER NOTE:
ALL DIMENSIONS SHOWN MUST BE VERIFIED PRIOR TO FABRICATION.

PLEASE NOTE:
ALL STRUCTURAL CURBS SHALL BE DESIGNED FOR THE LOADS IMPOSED BY THE SKYLIGHTS. THE STRENGTH, INTEGRITY, AND ACCURACY OF THE SUPPORTING STRUCTURE IS THE RESPONSIBILITY OF OTHERS.

CURB LAYOUT - PLAN VIEW
SCALE : 1/2" = 1'-0"
3

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Fax 714.545.2364
Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
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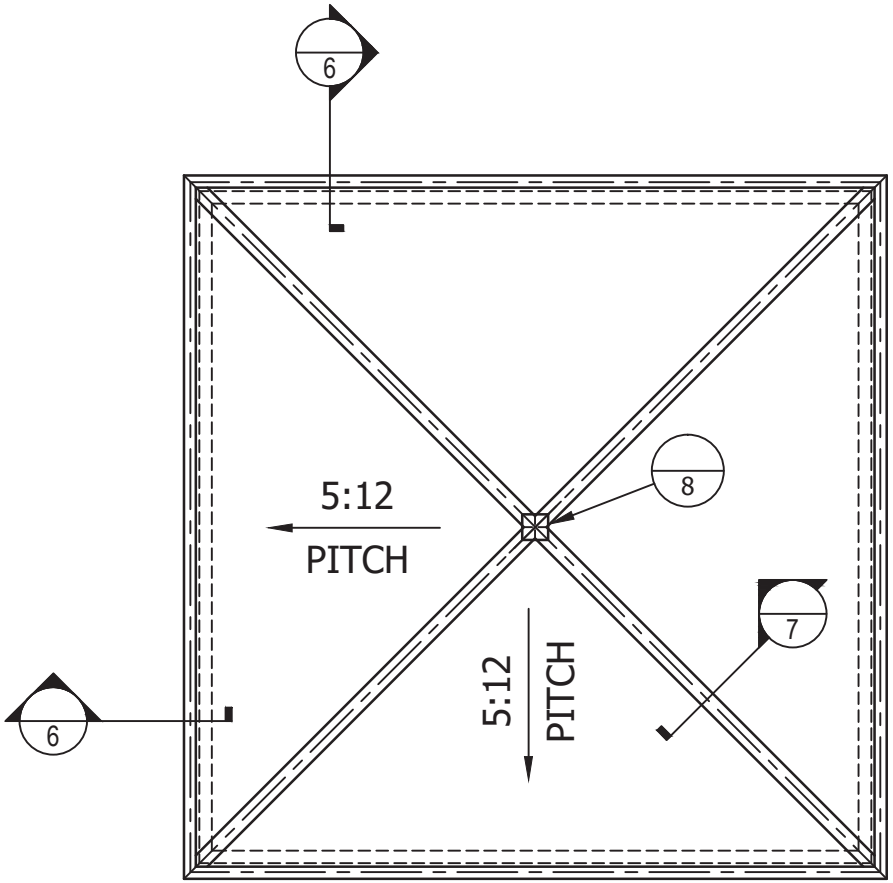
SHOP:
W.O.:
SHEET: 3 of 11

Q1703001-REV1.DWG



REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

QUANTITY = 1

PLEASE NOTE:
ALL STRUCTURAL CURBS SHALL BE DESIGNED FOR THE LOADS IMPOSED BY THE SKYLIGHTS. THE STRENGTH, INTEGRITY, AND ACCURACY OF THE SUPPORTING STRUCTURE IS THE RESPONSIBILITY OF OTHERS.

SKYLIGHT - PLAN VIEW
SCALE : 1/2" = 1'-0"
4

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CUSTOMER : Vogel & Associates
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SHOP:
W.O.:
SHEET: 4 of 11

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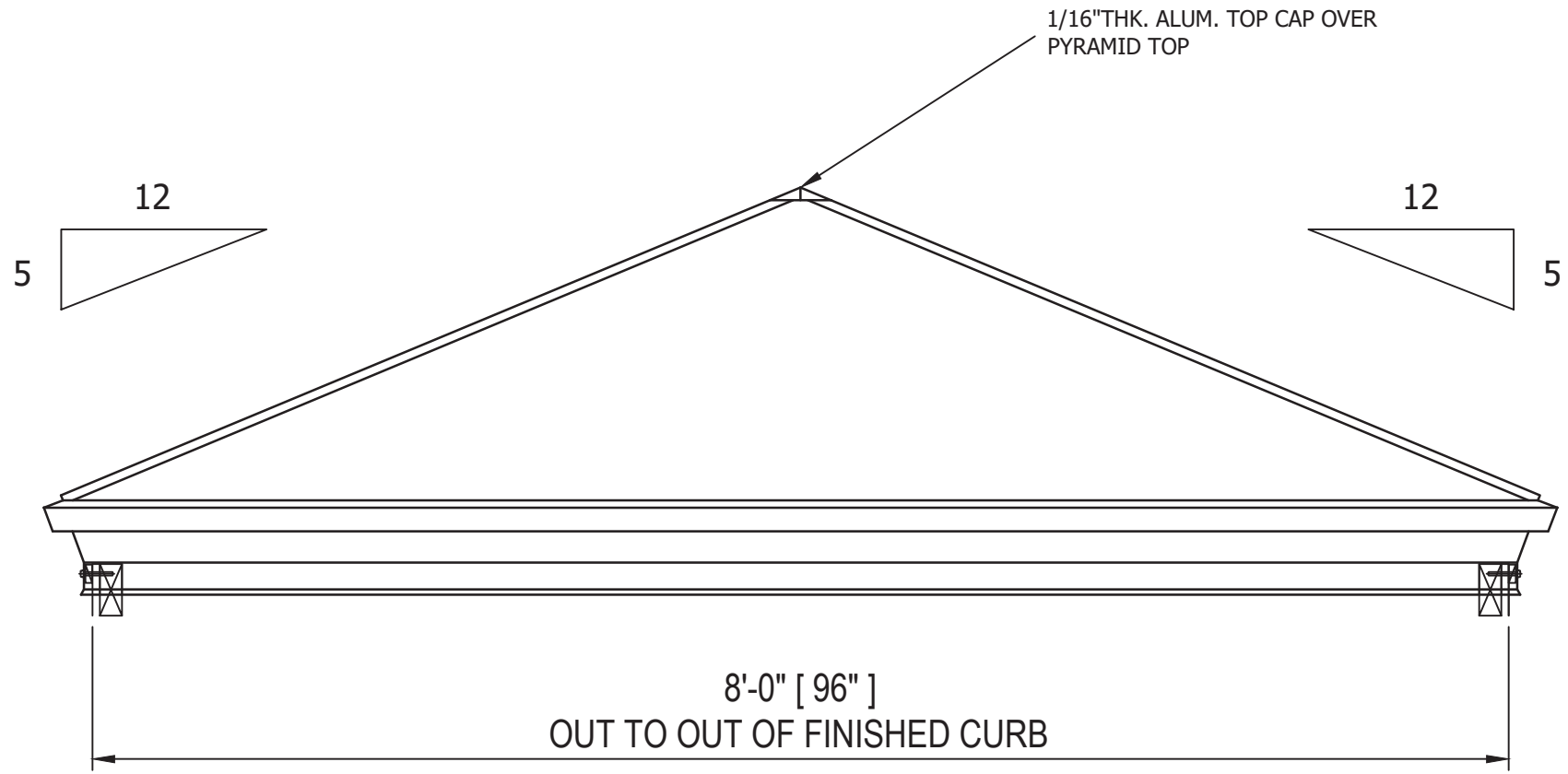

REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
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EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

PLEASE NOTE:
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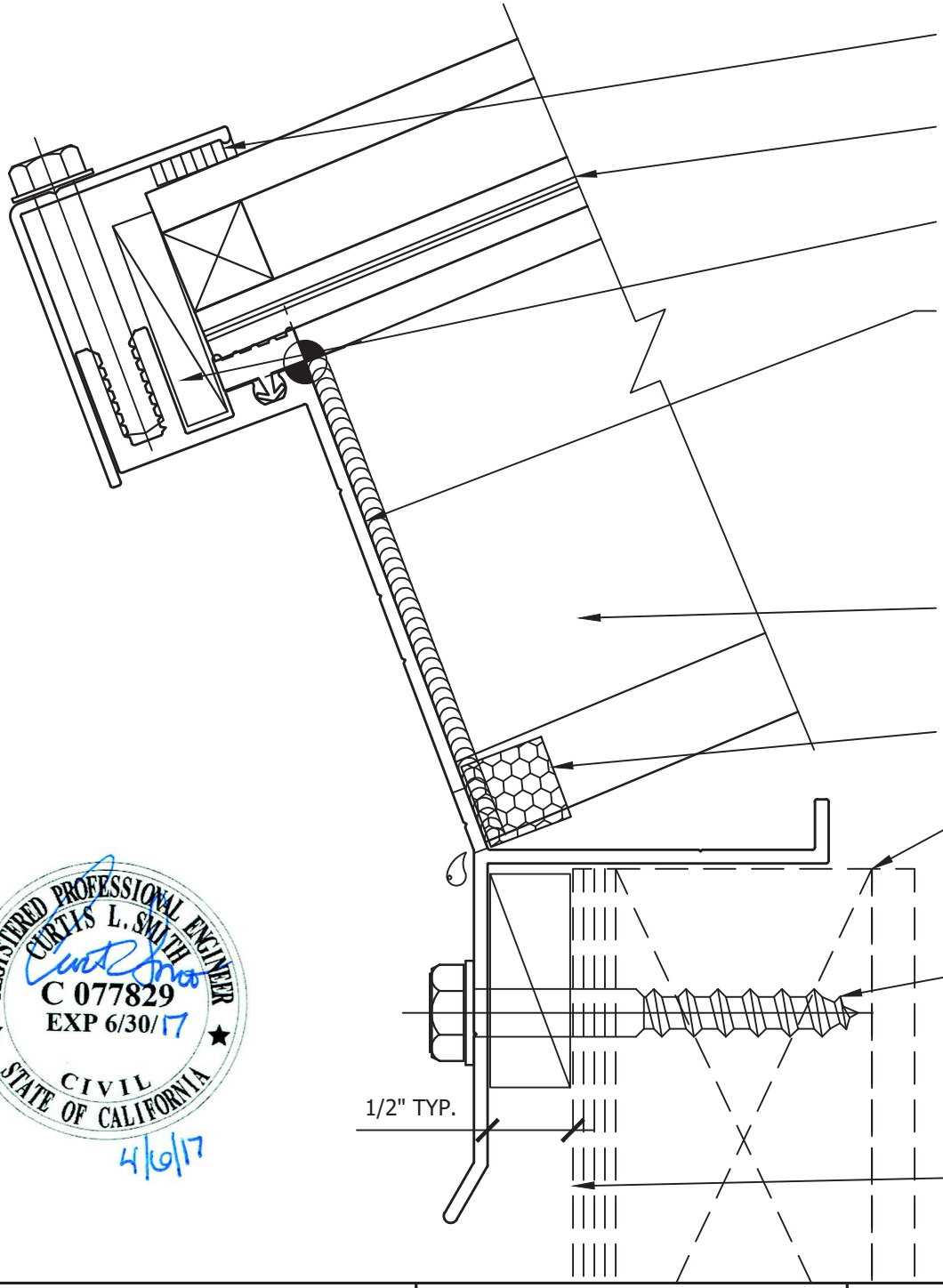
SKYLIGHT - ELEVATION VIEW
SCALE : 1" = 1'-0"
5

Kingspan Light + Air
401 E. Goetz Avenue
Santa Ana CA 92707
Tel 714.540.8950
Fax 714.545.2364
Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
REV: ----
SHOP:
W.O.:
SHEET: 5 of 11

Q1703001-REV1.DWG



REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

SILL DETAIL
SCALE : 1' = 1'-0"
6

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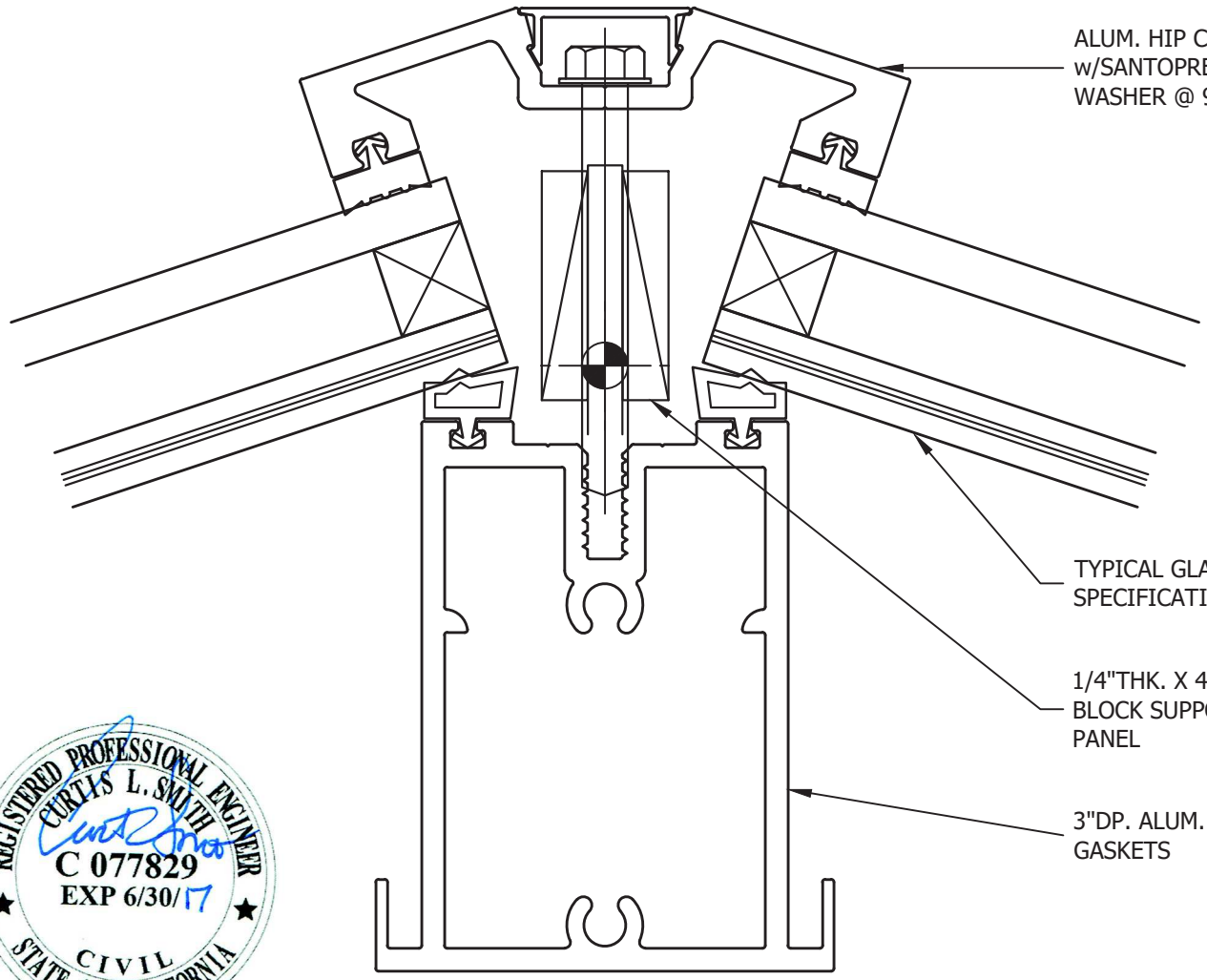
CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
REV: ----
SHOP:
W.O.:
SHEET: 6 of 11

Q1703001-REV1.DWG



REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

HIP RAFTER DETAIL | 7
SCALE : 1' = 1'-0"

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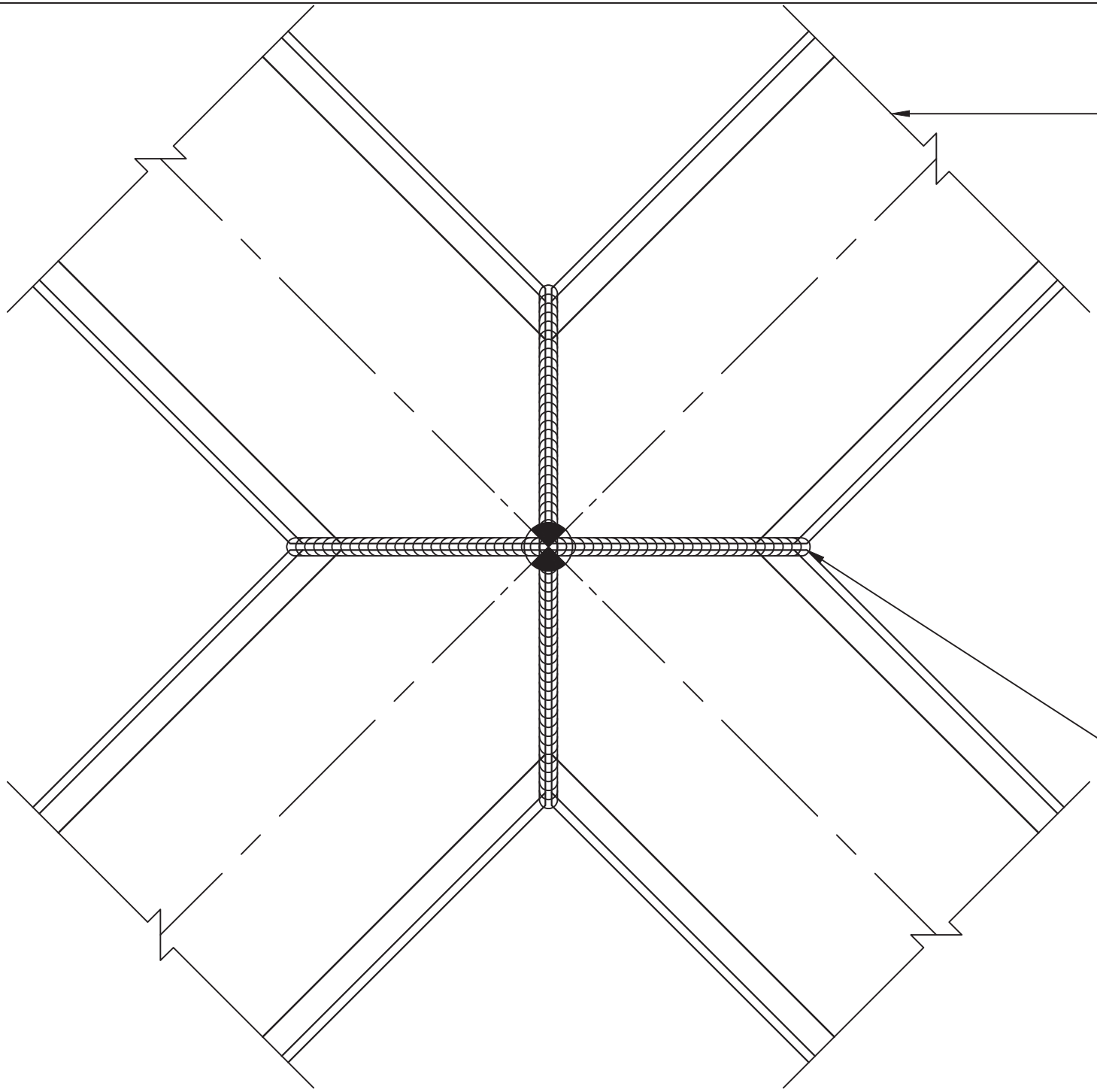
Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
REV: ----
SHOP:
W.O.:
SHEET: 7 of 11

Q1703001-REV1.DWG



REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

TOP OF SKYLIGHT / APEX DETAIL — 8

SCALE : 1' = 1'-0"

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401 E. Goetz Avenue
Santa Ana CA 92707
Tel 714.540.8950
Fax 714.545.2364

Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates

PROJECT : College of Marin

JOB NO: Q1703001

REV: ----

SHOP:

W.O.:

SHEET: 8 of 11

Q1703001-REV1.DWG

SECTION PROPERTIES - "SDM" SYSTEM

MEMBER	A	Ix	Iy	Sx	Sy	r
1" PURL	0.713	0.075	0.385	0.108	0.308	0.324
1.5"PURL	0.829	0.193	0.487	0.196	0.390	0.483
2" PURL	0.992	0.338	0.619	0.285	0.495	0.584
3" PURL	1.242	1.071	0.839	0.595	0.671	0.929
2" RFTR	1.275	0.645	0.742	0.637	0.594	0.711
3" RFTR	1.664	1.934	0.965	1.280	0.772	1.076
4" RFTR	1.914	4.013	1.185	1.986	0.948	1.448
5" RFTR	2.164	7.046	1.405	2.768	1.124	1.804
6" RFTR	2.414	11.159	1.625	3.641	1.300	2.150
3" HIP R	1.581	2.138	1.010	1.249	0.808	1.163

REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

SECTION PROPERTIES
SCALE : N.T.S.
9

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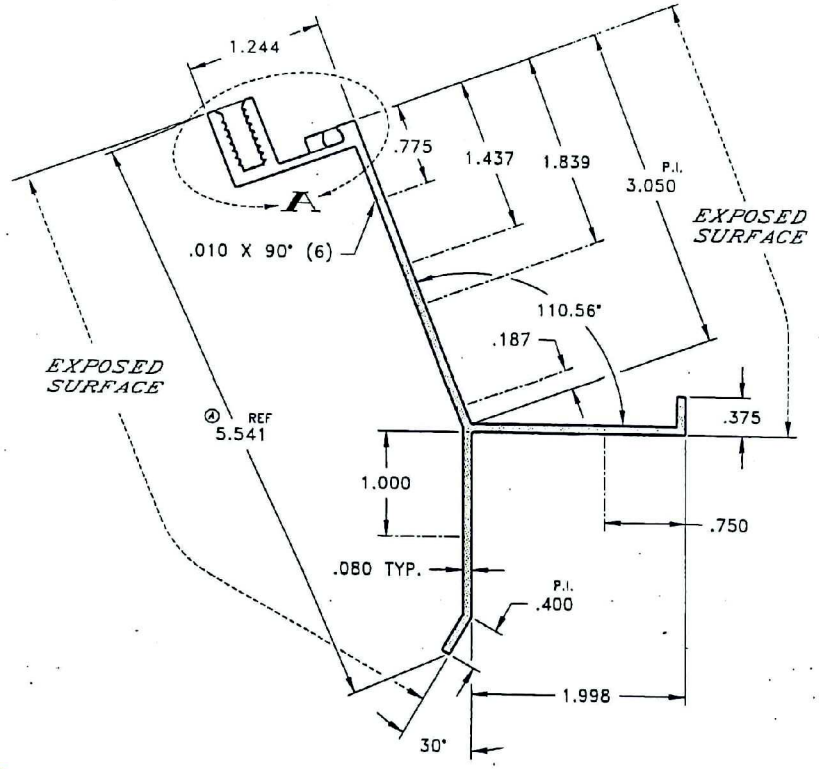
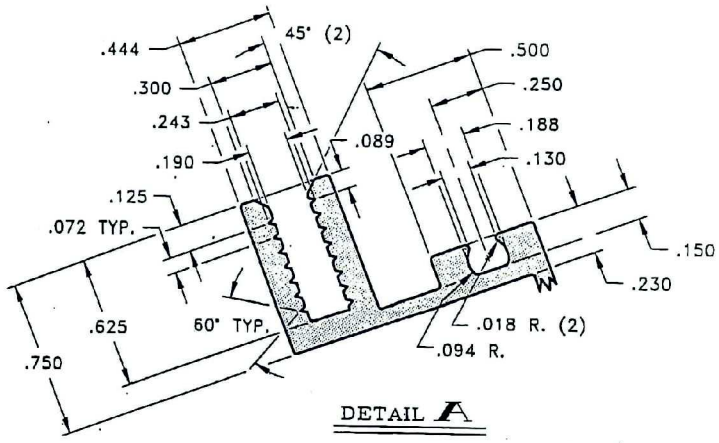
Tel 714.540.8950
Fax 714.545.2364
Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
REV: ----
SHOP:
W.O.:
SHEET: 9 of 11

HOLES 1	BACKER 18503	FEEDER 18503	BOLSTER 18503	DIE NO.
PS NO. 2828	PS DATE 6-12-00	DRAWN BY MP	DIE DATE 6-19-00	18503





DETAIL A

UNLESS OTHERWISE NOTED ALL SHARP CORNERS .015 R. AND TYPICAL WALL THICKNESS IS .080

UMEX Universal MOLDING EXTRUSION COMPANY
9151 EAST IMPERIAL HIGHWAY
DOWNEY, CALIFORNIA 90242
TELEPHONE (562) 940-0300
FAX NUMBER (562) 940-0839

		CUSTOMER NAME: BRISTOL FIBERLITE	AREA .903	SCALE: 1:1
		CUSTOMER PART NO. 0686	WT/FT 1.084	
			PERI 20.829	
6-30-00	A ADDED 5.541	STANDARD COMMERCIAL TOLERANCES AS PUBLISHED BY THE ALUMINUM ASSOCIATION, APPLY UNLESS SPECIFICALLY SHOWN OTHERWISE.	FACTOR 19	DIE NO. 18503
			CIRCLE SIZE 5.700	
DATE	REVISIONS		CLASS SEMI-HOLLOW	

REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

DIE DRAWING - CURB FRAME
SCALE : N.T.S.
10

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Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
REV: ----
SHOP:
W.O.:
SHEET: 10 of 11

Q1703001-REV1.DWG

Kingspan Light + Air

The new name for Bristolite Daylighting Systems

Custom Division
401 E. Goetz Ave., Santa Ana, CA 92707
Fax: 714/540-5415 Phone: 714/540-8950

Submittal Drawing Transmittal –Custom Division

TO:	Suzie Vogel	Date:	4/7/2017
Company:	Vogel and Associates	Page 1 of	12
Email:	sphilpot@vogelskylight.com	Please check the number of pages received with the number above.	
From:	April Byard	Notify the sender if any pages are missing or illegible by calling the Custom Division at **714/540-8950.**	
Subject:	College of Marin Indian Campus		

ACTION REQUIRED!

Following please find (1) set of Submittal Drawings for the Skylight(s) on the above referenced project. Please carefully review all ***Details, Dimensions*** and the ***"Specification Section" (1-10)*** on page 2 as this is also for approval.

Before any production begins we require the following:

- **ALL DIMENSIONS SHOWN ON THE SUBMITTAL DRAWING VERIFIED BY THE CUSTOMER.**
- **THE DIMENSIONS REQUIRED ARE OUT TO OUT OF FINISHED CURB.**
- **IT MAY BE NECESSARY TO FIELD MEASURE TO OBTAIN THESE DIMENSIONS.**
- **PLEASE RETURN THE SIGNED APPROVAL/GUARANTEE OF DIMENSIONS FORM WITH ANY CORRECTIONS NOTED.**

Please Note: Fabrication *will not* begin until we have a signed Approval Form *(sheet 1* of the submittal package).

The Lead Time for this project after receipt of All approvals and verified dimensions shall be: 6-8 Weeks.

APPROVAL / GUARANTEE OF DIMENSION FORM

Kingspan Light + Air

The new name for Bristolite Daylighting Systems

Customer: **Vogel and Associates**

Project: College of Marin Indian Campus

Date: 4=7=17 *Job No*: Q1703001

ACTION REQUIRED

No Fabrication Will Begin Until This Form Is Signed & Returned To Bristolite

Please Read Before Signing!

Kingspan Light + Air is responsible for furnishing skylight(s) to fit predetermined specified curb and roof opening dimensions. The strength, integrity and accuracy of the supporting structure is the responsibility of others.

This product(s) and the information disclosed is the property of Kingspan Light + Air. It is not to be used directly or indirectly in any way detrimental to the company patents, designs or interests.

Kingspan Light + Air is not responsible for spontaneous breakage of glass or glazing products.

See glazing manufacturers specifications and warranties for further information.

CAUTION: This skylight is designed to withstand normal elements of the weather. It is *not* designed to withstand human impact or falling objects. The skylight(s) should not be walked upon under any circumstances. The owner or designer should restrict access only to authorized personnel who have been adequately cautioned as to the location of the skylight(s) and informed of the warnings listed above, or said owner/designer should provide protective guard rails or screens around the unit(s).

Guarantee of Dimensions

Check The Appropriate Box

- [x] The Drawings & Field Dimensions **Are Approved**, begin production
- [ ] The Drawings & Field Dimensions **Are Approved With Corrections Noted, begin production**
- [ ] The Drawings **Are Rejected**, Please Resubmit Per Attached Notes. **Do Not Begin Production.**

Approval Signature: Mattison Ly Date: 17.06.20

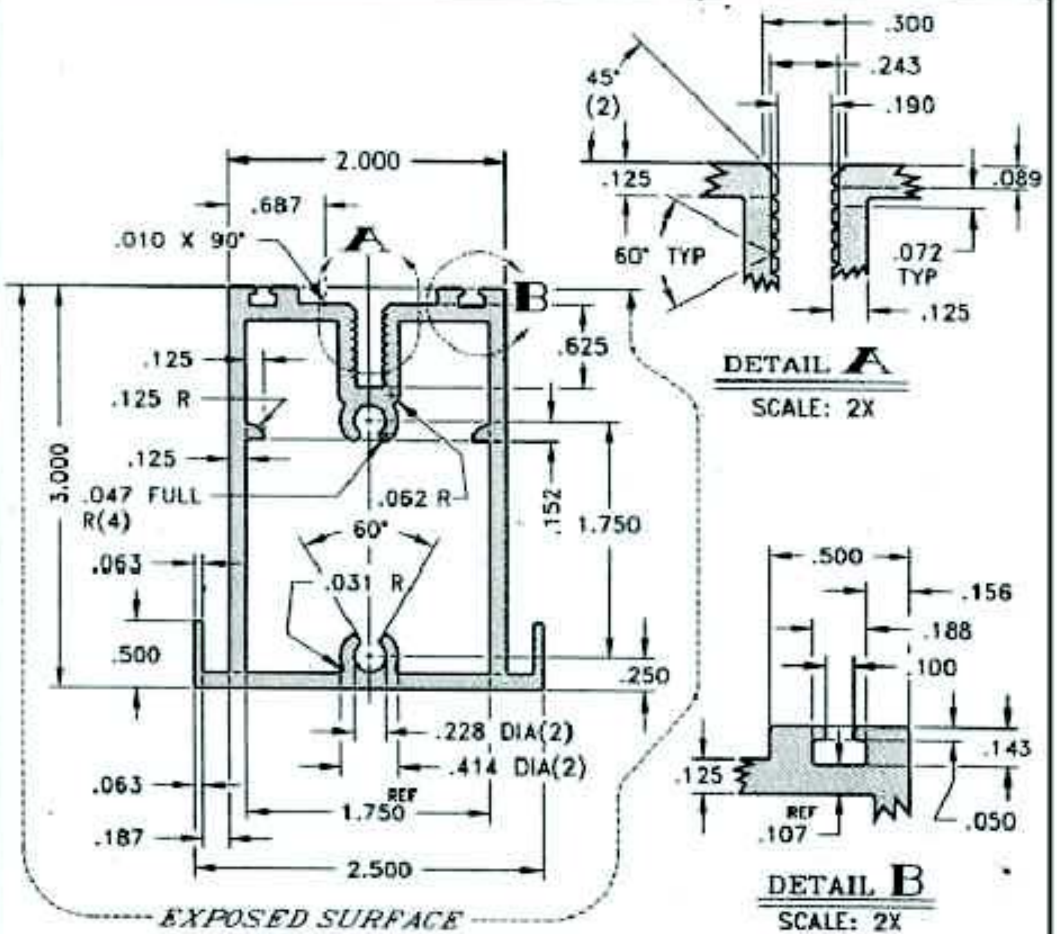
Please Provide Delivery/Ship To Address:

PROJECT SITE 1800 IGNACSIO BLVD. NOVATO, CA 94949
PLEASE CONTACT ARCHITECT PRIOR TO SHIPPING AND DELIVERY.

Kingspan Light + Air reserves the right to vary the actual skylight construction details from those indicated on the attached drawing(s). Any such change would be the result of structural*, fabrication, or design improvement considerations and would not alter the intent of the approved design.

* The actual size of the structural member depth can be referenced in the DESIGN DATA manual loadcharts

ALLOY: 6063-T5 FITS WITH	HOLES 1	BACKER –	FEEDER –	BOLSTER 16-1-14	DIE NO. 33551
	PS NO. 2949	PS DATE 6-08-00	DRAWN BY JHN	DIE DATE 6-13-00	



DETAIL A
SCALE: 2X

DETAIL B
SCALE: 2X

UNLESS OTHERWISE NOTED ALL SHARP CORNERS .016 R.

UMEX Universal MOLDING EXTRUSION COMPANY

9151 EAST IMPERIAL HIGHWAY
DOWNEY, CALIFORNIA 90242
TELEPHONE (562) 940-0300
FAX NUMBER (562) 940-0339

DATE	REVISIONS

CUSTOMER NAME: BRISTOL FIBERLITE
PART NAME: 3" TUBULAR RAFTER
PART NO.: 0540

STANDARD COMMERCIAL TOLERANCES AS PUBLISHED BY THE ALUMINUM ASSOCIATION, APPLY UNLESS SPECIFICALLY SHOWN OTHERWISE.

AREA	1.632
WT/FT	1.959
PERI	30.258
FACTOR	15
CIRCLE SIZE	3.800
CLASS	2-HOLLOW

SCALE: 1X

DIE NO. 33551

#CAD/14-5

REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

DIE DRAWING - 3" RAFTER
SCALE : N.T.S.
11

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Santa Ana CA 92707
Tel 714.540.8950
Fax 714.545.2364
Bristolite® Daylighting Systems

CUSTOMER : Vogel & Associates
PROJECT : College of Marin
JOB NO: Q1703001
REV: ----
SHOP:
W.O.:
SHEET: 11 of 11

Q1703001-REV1.DWG

Kingspan Light + Air

The new name for Bristolite Daylighting Systems

April 11, 2017

Vogel and Associates
242 Chesham Avenue
San Carlos, CA 94070

RE: College of Marin Indian Campus

Please use the enclosed color chart to select a color for the (2) Coat Kynar Finish for the skylight for the above referenced project. Please return this form with the color selection and Color Number.

Thank You,
April Byard

◆◆

Color Selection Information

Color UC#: 109862

Color Name: MEDIUM BRONZE

Signature: [signature] Date: 17.06.20

Duranar Coatings

2-Coat System: Primer & Color

The color chip samples and codes shown in this guide represent *Duranar* Extrusion Liquid Coatings. These same colors may be available for other coatings technologies and product lines. See the *Order Today* section for more detail and availability.

01. Bone White UC43350 SRI 88	02. Graham White UC72638 SRI 95	03. Bone White UC109880 SRI 84	04. Bright White UC55026 SRI 95	05. Colonial White UC54983 SRI 88
06. Ivory UC54412 SRI 74	07. Malt UC105738 SRI 74	08. Natural Wicker UC105747 SRI 86	09. Caramel Latte UC105737 SRI 70	10. Sahara Sand UC72861 SRI 62
11. Sandstone UC109856 SRI 59	12. Beige UC54137 SRI 61	13. Seawolf UC109855 SRI 43	14. Antique Bronze UC100027 SRI 29	15. Fairview Taupe UC105741 SRI 17
16. Cocoa Bean UC105735 SRI 8	17. Medium Bronze UC109862 SRI 10	18. Bronze UC110460 SRI 2	19. Statuary Bronze UC43347 SRI 2	20. Bronze UC109850 SRI 2
21. Brick Red UC43355 SRI 31	22. River Rouge Red UC52006 SRI 19	23. Roasted Red Pepper* UC102320XL SRI 48	24. Aged Copper UC54434 SRI 49	25. Bermuda Blue UC106661 SRI 12
26. Fashion Gray UC51825 SRI 33	27. Eclipse Gray UC106669 SRI 8	28. Charcoal UC109852 SRI 4	29. Charcoal Gray UC54271 SRI 4	30. Black UC40577 SRI -3

**Duranar* XL Coatings (3-coat system) color requires XL clear coat due to pigmentation

Customer: 1-1/16" Grey IGU with SB60#2

ARCHITECTURAL GUIDE SPECIFICATION
SECTION 08 81 00 GLASS GLAZING

Note to Specifiers:

The specifications below are suggested as desirable inclusions in glass and glazing specifications (section 08 81 00), but are not intended to be complete. An appropriate and qualified Architect or Engineer must verify suitability of a particular product for use in a particular application as well as review final specifications. Oldcastle BuildingEnvelope® assumes no responsibility or liability for the information included or not included in these specifications.

PRODUCTS

Approved Glass Fabricator Oldcastle BuildingEnvelope®

Glass Description FLOAT GLASS

1. USA - Annealed float glass shall comply with ASTM C1036, Type I, Class 1 (clear), Class 2 (tinted), Quality-Q3. Canada - Annealed float glass shall comply with CAN/CGSB-12.3-M, Quality-Glazing.

2. USA- Heat-strengthened float glass shall comply with ASTM C1048, Type I, Class 1 (clear), Class 2 (tinted), Quality Q3, Kind HS. Canada - Heat-strengthened float glass shall comply with CAN/CGSB-12.9-M, Type 2-Heat-Strengthened Glass, Class A-Float Glass.

3. USA - Tempered float glass shall comply with ASTM C1048, Type I, Class 1 (clear), Class 2 (tinted), Quality Q3, Kind FT. Canada - Tempered float glass shall comply with CAN/CGSB-12.1-M, Type 2-Tempered Glass, Class B-Float Glass.

4. USA - Laminated glass to comply with ASTM C1172. Canada - Laminated glass to comply with CAN/CGSB-12.1-M, Type 1-Laminated Glass, Class B-Float Glass.

5. Glass shall be annealed, heat-strengthened or tempered as required by codes, or as required to meet thermal stress and wind loads.

Sealed Insulating Glass (IG) Vision Glass (Vertical) GENERAL

1. IG units consist of glass lites separated by a dehydrated airspace that is hermetically dual sealed with a primary seal of polyisobutylene (PIB) and a secondary seal of silicone or an organic sealant depending on the application.

2. USA - Insulating glass units are certified through the Insulating Glass Certification Council (IGCC) to ASTM E2190. Canada - Insulating Glass units are certified through the Insulating Glass Manufacturers Alliance (IGMA) to either the IGMAC certification program to CAN/CGSB-12.8, or through the IGMA program to ASTM E2190.

IG VISION UNIT PERFORMANCE CHARACTERISTICS

1. Exterior Lite
1/4" PPG Solarban® 60 on Solargray® Low-E #2

2. Interior Lite
5/16" Laminate - 1/8" Clear - 0.060" Clear PVB - 1/8" Clear

3. 1/2" Cavity
1/2 inch (Air Fill)

4. Performance Characteristics

Thermal		Optical	
Winter U-factor/U-value:	0.29	Visible Light Transmittance:	35%
Summer U-factor/U-value:	0.27	Visible Light Reflectance (outside):	6%
Solar Heat Gain Coefficient:	0.25	Visible Light Reflectance (inside):	10%
Shading Coefficient:	0.29	Total Solar Transmittance:	17%
Relative Heat Gain (Btu/hr-ft²):	61	Total Solar Reflectance (outside):	12%
Light to Solar Gain:	1.40	Ultraviolet Transmittance:	<1%

exterior glazing lite should be tempered per State Fire Marshall for projects in Wildland Urban Interface (WUI) zones

brick.

- [x] reviewed with no exceptions
- [ ] rejected
- [ ] revise as noted
- [ ] revise and resubmit
- [ ] submit specified item
- [ ] not reviewed

Submittal was reviewed for general conformance to the design intent only. The Contractor is responsible for confirming and correlating dimensions at the job sites for tolerances, clearances, quantities, fabrication processes and techniques of construction, and coordination of work with other trades.

reviewed by MATTISON LY date 17.06.20

Contact Oldcastle BuildingEnvelope® at 866-Oldcastle (653-2278) for samples or additional information concerning performance, strength, deflection, thermal stress or application guidelines. GlasSelect® calculates center of glass performance data using the Lawrence Berkeley National Laboratory (LBNL) Window 6.3 program (version 6.3.74.0) with Environmental Conditions set at NFRC 100-2010. Gas Library ID#1 (Air) is used for Insulating Glass units with air. Gas Library ID#9 (10% Air/90% Argon) is used for Insulating Glass units with argon. Monolithic glass data is from the following sources: 1. LBNL International Glazing Database (IGDB) version 44.0; 2. Vendor supplied spectral data files. Laminated glass data is from the following sources: 1. LBNL International Glazing Database (IGDB) version 44.0; 2. LBNL Optics 6 (version 6.0 Maintenance Pack 1); 3. Vendor supplied spectral data files; 4. Vendor supplied data. 5. Based on vendor testing, clear acid-etched glass performance data is estimated using regular clear glass of equivalent thickness. Thermal values are in Imperial units.

CLS ENGINEERING INC.

Structural Calculation Cover Sheet

brick.

- [x] reviewed with no exceptions
- [ ] rejected
- [ ] revise as noted
- [ ] revise and resubmit
- [ ] submit specified item
- [ ] not reviewed

Submittal was reviewed for general conformance to the design intent only. The Contractor is responsible for confirming and correlating dimensions at the job sites for tolerances, clearances, quantities, fabrication processes and techniques of construction, and coordination of work with other trades.

reviewed by MATTISON LY date 17.06.20

April 6, 2017

Kingspan
Attn: April Byard

College of Marin
Novato, CA

Contractor Submittal Review
Reviewed only for general compliance with the contract documents. Contractor is responsible for: correctness of all quantities and dimensions which shall be confirmed and correlated on the job site, fabrication process and techniques of construction, coordination of all work with that of various trades and the satisfactory performance of all work.
[X] REVIEWED [ ] MAKE CORRECTIONS NOTED
[ ] REJECTED [ ] REVISE & RESUBMIT
IDA Structural Engineers, Inc.
By: msekel Date: 08/30/2017

Skylight Units:
(1) 96” x 96” 22.62° Pyramid Skylight

Design Criteria
Code: 2016 California Building Code
Dead Load: 12 psf
Roof Live Load: 20 psf
Wind Speed: 115 mph Exposure ‘C’ (Ultimate)
Deflection Limit: L/180
Building Category: III

REGISTERED PROFESSIONAL ENGINEER
CURTIS L. SMITH
C 077829
EXP 6/30/17
CIVIL
STATE OF CALIFORNIA
4/6/17

Total Pages of Calculations: 18 Pages
Including Calculation Cover Sheet

28258 470th Ave Lennox, SD 57039
Phone: (605) 201-7921 Email: clsmithpe@gmail.com

CLS ENGINEERING INC.				
	Client: **Bristolite Skylights**	Date:	**4/5/2017**	
	Project: **College of Marin**	Project #:	**Q1703001**	/
	Location: **Novato, CA**	Designed By:	**CLS**	

Design Criteria

Code:	2016 California Building Code	
Roof Dead Load:	12	psf
Ground Snow Load:	0	psf
Roof Snow Load:	0	psf
Roof Live Load:	20	psf
Wind Speed (V_{ULT}):	115	MPH
Exposure Category:	C	
Building Type:	Fully Enclosed	
Building Category:	III	
Seismic Design Cat:	D	
Deflection Limit: L/	180	
Curb Height:	< 40	feet

Client:	**Bristolite Skylights**	Date:	**4/5/2017**
Project:	**College of Marin**	Project #:	**Q1703001**
Location:	**Novato, CA**	Designed By:	**CLS**

2

Design Wind Loads:

$p = EAF \times RF \times K_{zt} \times p_{table}$

EAF =	**1**	
K_{zt} =	**1**	
RF =	**1**	
p_{table} =	**20.4**	psf (Inward)
	-56.5	psf (Outward)
ASD Factor:	**0.6**	

Walls:Inward p_{net} =	12.24	psf (WL1)
Walls: Outward p_{net} =	-33.9	psf (WL2)

Design Loads:

DL =	12	psf
LL/SL =	20	psf
WL1 =	12.24	psf
WL2 =	-33.9	psf

ASD Load Combinations:

1. DL + LL =	32	psf
2. DL + 0.75LL + 0.75WL1 =	36.18	psf
3. DL + 0.75LL + 0.75WL2 =	1.575	psf
4. DL + WL1 =	24.24	psf
5. DL + WL2 =	-21.9	psf
6. 0.6DL + WL1 =	19.44	psf
7. 0.6DL + WL2 =	-26.7	psf

Maximum Gravity Load =	36.18	psf
Maximum Uplift Load =	-26.7	psf

Joint Coordinates and Temperatures

	Label	X [in]	Y [in]	Z [in]	Temp [F]	Detach From Diap...
1	N1	0	0	0	0	
2	N2	48	20	48	0	
3	N3	96	0	0	0	
4	N4	96	0	96	0	
5	N5	0	0	96	0	

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2			3" Hip Rafter	Beam	None	gen_Alum	Typical
2	M2	N3	N2			3" Hip Rafter	Beam	None	gen_Alum	Typical
3	M3	N5	N2			3" Hip Rafter	Beam	None	gen_Alum	Typical
4	M4	N4	N2			3" Hip Rafter	Beam	None	gen_Alum	Typical

General Material Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]
1	gen_Conc3NW	3155	1372	.15	.6	.145
2	gen_Conc4NW	3644	1584	.15	.6	.145
3	gen_Conc3LW	2085	906	.15	.6	.11
4	gen_Conc4LW	2408	1047	.15	.6	.11
5	gen_Alum	10100	4077	.3	1.29	.173
6	gen_Steel	29000	11154	.3	.65	.49
7	RIGID	1e+6		.3	0	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction				
2	N3	Reaction	Reaction	Reaction				
3	N4	Reaction	Reaction	Reaction				
4	N5	Reaction	Reaction	Reaction				

Joint Loads and Enforced Displacements (BLC 5 : Conc. Load #1)

	Joint Label	L,D,M	Direction	Magnitude[(lb,lb-in), (in,rad), (lb*s^2/in, lb*s^2*i...
1	N2	L	Y	-300

Member Point Loads (BLC 6 : Conc. Load #2)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[in,%]
1	M1	Y	-300	21.792

Member Distributed Loads (BLC 1 : Dead Load)

	Member Label	Direction	Start Magnitud...	End Magnitude[lb/ft,F]	Start Location[in,%]	End Location[in,%]
1	M1	Y	-96	0	0	1200
2	M2	Y	-96	0	0	1200
3	M3	Y	-96	0	0	1200
4	M4	Y	-96	0	0	1200

Member Distributed Loads (BLC 2 : Roof Live Load)

	Member Label	Direction	Start Magnitud...	End Magnitude[lb/ft,F]	Start Location[in,%]	End Location[in,%]

Member Distributed Loads (BLC 2 : Roof Live Load) (Continued)

	Member Label	Direction	Start Magnitud...	End Magnitude[lb/ft,F]	Start Location[in,%]	End Location[in,%]
1	M1	Y	-160	0	0	1200
2	M2	Y	-160	0	0	1200
3	M3	Y	-160	0	0	1200
4	M4	Y	-160	0	0	1200

Member Distributed Loads (BLC 3 : Wind Load (+))

	Member Label	Direction	Start Magnitud...	End Magnitude[lb/ft,F]	Start Location[in,%]	End Location[in,%]
1	M1	V	-98	0	0	1200
2	M2	V	-98	0	0	1200
3	M3	V	-98	0	0	1200
4	M4	V	-98	0	0	1200

Member Distributed Loads (BLC 4 : Wind Load (-))

	Member Label	Direction	Start Magnitud...	End Magnitude[lb/ft,F]	Start Location[in,%]	End Location[in,%]
1	M1	V	271.2	0	0	1200
2	M2	V	271.2	0	0	1200
3	M3	V	271.2	0	0	1200
4	M4	V	271.2	0	0	1200

Basic Load Cases

	BLC Description	Category	X Grav...	Y Grav...	Z Grav...	Joint	Point	Distributed	Area(M...	Surfac...
1	Dead Load	DL		1				4		
2	Roof Live Load	RLL		1				4		
3	Wind Load (+)	WL+Y		1				4		
4	Wind Load (-)	WL-Y		1				4		
5	Conc. Load #1	LL		1		1				
6	Conc. Load #2	LL		1			1			

Load Combinations

	Description	Sol...	PDelta	SRSS	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...
1	DL	Yes			1	1														
2	DL+Lr	Yes			1	1	2	1												
3	DL+0.75Lr+0...	Yes			1	1	3	.75	2	.75										
4	DL+0.75Lr+0...	Yes			1	1	4	.75	2	.75										
5	DL+WL+	Yes			1	1	3	1												
6	DL+WL-	Yes			1	1	4	1												
7	0.6DL+WL+	Yes			1	.6	3	1												
8	0.6DL+WL-	Yes			1	.6	4	1												
9	DL + CL#1				1	.6	4	1	1	1	5									
10	DL + CL#2				1	.6	4	1	1	1	6									

Member Section Deflections

	LC	Member Label	Sec	x [in]	y [in]	z [in]	x Rotate[rad]	(n) L/y Ratio	(n) L/z Ratio
1	1	M1	1	0	0	0	0	NC	NC
2			2	0	-.12	0	0	599.871	NC
3			3	-.001	-.005	0	0	NC	NC
4	2	M1	1	0	0	0	0	NC	NC
5			2	-.002	-.324	0	0	222.658	NC
6			3	-.004	-.013	0	0	NC	NC
7	3	M1	1	0	0	0	0	NC	NC
8			2	-.002	-.362	0	0	199.666	NC
9			3	-.004	-.014	0	0	NC	NC

Member Section Deflections (Continued)

	LC	Member Label	Sec	x [in]	y [in]	z [in]	x Rotate[rad]	(n) L/y Ratio	(n) L/z Ratio
10	4	M1	1	0	0	0	0	NC	NC
11			2	0	-.015	0	0	4853.764	NC
12			3	0	0	0	0	NC	NC
13	5	M1	1	0	0	0	0	NC	NC
14			2	-.001	-.238	0	0	303.216	NC
15			3	-.003	-.009	0	0	NC	NC
16	6	M1	1	0	0	0	0	NC	NC
17			2	.001	.224	0	0	322.047	NC
18			3	.003	.009	0	0	NC	NC
19	7	M1	1	0	0	0	0	NC	NC
20			2	-.001	-.19	0	0	380.06	NC
21			3	-.002	-.007	0	0	NC	NC
22	8	M1	1	0	0	0	0	NC	NC
23			2	.002	.272	0	0	265.115	NC
24			3	.003	.011	0	0	NC	NC
25	1	M2	1	0	0	0	0	NC	NC
26			2	0	-.12	0	0	599.871	NC
27			3	-.001	-.005	0	0	NC	NC
28	2	M2	1	0	0	0	0	NC	NC
29			2	-.002	-.324	0	0	222.658	NC
30			3	-.004	-.013	0	0	NC	NC
31	3	M2	1	0	0	0	0	NC	NC
32			2	-.002	-.362	0	0	199.666	NC
33			3	-.004	-.014	0	0	NC	NC
34	4	M2	1	0	0	0	0	NC	NC
35			2	0	-.015	0	0	4853.764	NC
36			3	0	0	0	0	NC	NC
37	5	M2	1	0	0	0	0	NC	NC
38			2	-.001	-.238	0	0	303.216	NC
39			3	-.003	-.009	0	0	NC	NC
40	6	M2	1	0	0	0	0	NC	NC
41			2	.001	.224	0	0	322.047	NC
42			3	.003	.009	0	0	NC	NC
43	7	M2	1	0	0	0	0	NC	NC
44			2	-.001	-.19	0	0	380.06	NC
45			3	-.002	-.007	0	0	NC	NC
46	8	M2	1	0	0	0	0	NC	NC
47			2	.002	.272	0	0	265.115	NC
48			3	.003	.011	0	0	NC	NC
49	1	M3	1	0	0	0	0	NC	NC
50			2	0	-.12	0	0	599.871	NC
51			3	-.001	-.005	0	0	NC	NC
52	2	M3	1	0	0	0	0	NC	NC
53			2	-.002	-.324	0	0	222.658	NC
54			3	-.004	-.013	0	0	NC	NC
55	3	M3	1	0	0	0	0	NC	NC
56			2	-.002	-.362	0	0	199.666	NC
57			3	-.004	-.014	0	0	NC	NC
58	4	M3	1	0	0	0	0	NC	NC
59			2	0	-.015	0	0	4853.764	NC
60			3	0	0	0	0	NC	NC
61	5	M3	1	0	0	0	0	NC	NC
62			2	-.001	-.238	0	0	303.216	NC
63			3	-.003	-.009	0	0	NC	NC
64	6	M3	1	0	0	0	0	NC	NC
65			2	.001	.224	0	0	322.047	NC
66			3	.003	.009	0	0	NC	NC

Member Section Deflections (Continued)

	LC	Member Label	Sec	x [in]	y [in]	z [in]	x Rotate[rad]	(n) L/y Ratio	(n) L/z Ratio
67	7	M3	1	0	0	0	0	NC	NC
68			2	-.001	-.19	0	0	380.06	NC
69			3	-.002	-.007	0	0	NC	NC
70	8	M3	1	0	0	0	0	NC	NC
71			2	.002	.272	0	0	265.115	NC
72			3	.003	.011	0	0	NC	NC
73	1	M4	1	0	0	0	0	NC	NC
74			2	0	-.12	0	0	599.871	NC
75			3	-.001	-.005	0	0	NC	NC
76	2	M4	1	0	0	0	0	NC	NC
77			2	-.002	-.324	0	0	222.658	NC
78			3	-.004	-.013	0	0	NC	NC
79	3	M4	1	0	0	0	0	NC	NC
80			2	-.002	-.362	0	0	199.666	NC
81			3	-.004	-.014	0	0	NC	NC
82	4	M4	1	0	0	0	0	NC	NC
83			2	0	-.015	0	0	4853.764	NC
84			3	0	0	0	0	NC	NC
85	5	M4	1	0	0	0	0	NC	NC
86			2	-.001	-.238	0	0	303.216	NC
87			3	-.003	-.009	0	0	NC	NC
88	6	M4	1	0	0	0	0	NC	NC
89			2	.001	.224	0	0	322.047	NC
90			3	.003	.009	0	0	NC	NC
91	7	M4	1	0	0	0	0	NC	NC
92			2	-.001	-.19	0	0	380.06	NC
93			3	-.002	-.007	0	0	NC	NC
94	8	M4	1	0	0	0	0	NC	NC
95			2	.002	.272	0	0	265.115	NC
96			3	.003	.011	0	0	NC	NC

Member Section Forces (By Item)

	LC	Member Label	Sec	Axial[lb]	y Shear[lb]	z Shear[lb]	Torque[lb-in]	y-y Mo...	z-z Mo...
1	1	M1	1	365.8	175.647	0	0	0	0
2			2	307.383	-22.627	0	0	0	-2306.873
3			3	288.966	-85.137	0	0	0	0
4	2	M1	1	989.734	471.974	0	0	0	0
5			2	832.899	-60.34	0	0	0	-6215.026
6			3	782.732	-230.615	0	0	0	0
7	3	M1	1	1102.065	526.806	0	0	0	0
8			2	926.957	-67.53	0	0	0	-6930.704
9			3	871.226	-256.687	0	0	0	0
10	4	M1	1	30.765	25.964	0	0	0	0
11			2	21.664	-4.924	0	0	0	-285.104
12			3	21.269	-6.266	0	0	0	0
13	5	M1	1	723.553	347.532	0	0	0	0
14			2	607.966	-44.785	0	0	0	-4563.828
15			3	571.547	-168.394	0	0	0	0
16	6	M1	1	-704.847	-320.257	0	0	0	0
17			2	-599.091	38.689	0	0	0	4296.972
18			3	-561.729	165.501	0	0	0	0
19	7	M1	1	577.233	277.273	0	0	0	0
20			2	485.013	-35.734	0	0	0	-3641.078
21			3	455.961	-134.339	0	0	0	0
22	8	M1	1	-851.167	-390.516	0	0	0	0
23			2	-722.045	47.74	0	0	0	5219.722

Member Section Forces (By Item) (Continued)

	LC	Member Label	Sec	Axial[lb]	y Shear[lb]	z Shear[lb]	Torque[lb-in]	y-y Mo...	z-z Mo...
24			3	-677.315	199.556	0	0	0	0
25	1	M2	1	365.8	175.647	0	0	0	0
26			2	307.383	-22.627	0	0	0	-2306.873
27			3	288.966	-85.137	0	0	0	0
28	2	M2	1	989.734	471.974	0	0	0	0
29			2	832.899	-60.34	0	0	0	-6215.026
30			3	782.732	-230.615	0	0	0	0
31	3	M2	1	1102.065	526.806	0	0	0	0
32			2	926.957	-67.53	0	0	0	-6930.704
33			3	871.226	-256.687	0	0	0	0
34	4	M2	1	30.765	25.964	0	0	0	0
35			2	21.664	-4.924	0	0	0	-285.104
36			3	21.269	-6.266	0	0	0	0
37	5	M2	1	723.553	347.532	0	0	0	0
38			2	607.966	-44.785	0	0	0	-4563.828
39			3	571.547	-168.394	0	0	0	0
40	6	M2	1	-704.847	-320.257	0	0	0	0
41			2	-599.091	38.689	0	0	0	4296.972
42			3	-561.729	165.501	0	0	0	0
43	7	M2	1	577.233	277.273	0	0	0	0
44			2	485.013	-35.734	0	0	0	-3641.078
45			3	455.961	-134.339	0	0	0	0
46	8	M2	1	-851.167	-390.516	0	0	0	0
47			2	-722.045	47.74	0	0	0	5219.722
48			3	-677.315	199.556	0	0	0	0
49	1	M3	1	365.8	175.647	0	0	0	0
50			2	307.383	-22.627	0	0	0	-2306.873
51			3	288.966	-85.137	0	0	0	0
52	2	M3	1	989.734	471.974	0	0	0	0
53			2	832.899	-60.34	0	0	0	-6215.026
54			3	782.732	-230.615	0	0	0	0
55	3	M3	1	1102.065	526.806	0	0	0	0
56			2	926.957	-67.53	0	0	0	-6930.704
57			3	871.226	-256.687	0	0	0	0
58	4	M3	1	30.765	25.964	0	0	0	0
59			2	21.664	-4.924	0	0	0	-285.104
60			3	21.269	-6.266	0	0	0	0
61	5	M3	1	723.553	347.532	0	0	0	0
62			2	607.966	-44.785	0	0	0	-4563.828
63			3	571.547	-168.394	0	0	0	0
64	6	M3	1	-704.847	-320.257	0	0	0	0
65			2	-599.091	38.689	0	0	0	4296.972
66			3	-561.729	165.501	0	0	0	0
67	7	M3	1	577.233	277.273	0	0	0	0
68			2	485.013	-35.734	0	0	0	-3641.078
69			3	455.961	-134.339	0	0	0	0
70	8	M3	1	-851.167	-390.516	0	0	0	0
71			2	-722.045	47.74	0	0	0	5219.722
72			3	-677.315	199.556	0	0	0	0
73	1	M4	1	365.8	175.647	0	0	0	0
74			2	307.383	-22.627	0	0	0	-2306.873
75			3	288.966	-85.137	0	0	0	0
76	2	M4	1	989.734	471.974	0	0	0	0
77			2	832.899	-60.34	0	0	0	-6215.026
78			3	782.732	-230.615	0	0	0	0
79	3	M4	1	1102.065	526.806	0	0	0	0
80			2	926.957	-67.53	0	0	0	-6930.704

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Member Section Forces (By Item) (Continued)

	LC	Member Label	Sec	Axial[lb]	y Shear[lb]	z Shear[lb]	Torque[lb-in]	y-y Mo...	z-z Mo...
81			3	871.226	-256.687	0	0	0	0
82	4	M4	1	30.765	25.964	0	0	0	0
83			2	21.664	-4.924	0	0	0	-285.104
84			3	21.269	-6.266	0	0	0	0
85	5	M4	1	723.553	347.532	0	0	0	0
86			2	607.966	-44.785	0	0	0	-4563.828
87			3	571.547	-168.394	0	0	0	0
88	6	M4	1	-704.847	-320.257	0	0	0	0
89			2	-599.091	38.689	0	0	0	4296.972
90			3	-561.729	165.501	0	0	0	0
91	7	M4	1	577.233	277.273	0	0	0	0
92			2	485.013	-35.734	0	0	0	-3641.078
93			3	455.961	-134.339	0	0	0	0
94	8	M4	1	-851.167	-390.516	0	0	0	0
95			2	-722.045	47.74	0	0	0	5219.722
96			3	-677.315	199.556	0	0	0	0

General Section Sets

	Label	Shape	Type	Material	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	GEN1A	RE4X4	Beam	gen_Conc3NW	16	21.333	21.333	31.573
2	RIGID		None	RIGID	1e+6	1e+6	1e+6	1e+6

Joint Reactions (By Item)

DL+.75LL+.75WL →

DL+WL →

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	1	N1	213.014	271.868	213.014	0	LOCKED	LOCKED
2	2		576.997	732.448	576.997	0	LOCKED	LOCKED
3	3		642.232	816.791	642.232	0	LOCKED	LOCKED
4	4		15.679	33.6	15.679	0	LOCKED	LOCKED
5	5		421.321	537.852	421.321	0	LOCKED	LOCKED
6	6		-414.083	-506.403	-414.083	0	LOCKED	LOCKED
7	7		336.115	429.105	336.115	0	LOCKED	LOCKED
8	8		-499.289	-615.15	-499.289	0	LOCKED	LOCKED
9	1	N3	-213.014	271.868	213.014	0	LOCKED	LOCKED
10	2		-576.997	732.448	576.997	0	LOCKED	LOCKED
11	3		-642.232	816.791	642.232	0	LOCKED	LOCKED
12	4		-15.679	33.6	15.679	0	LOCKED	LOCKED
13	5		-421.321	537.852	421.321	0	LOCKED	LOCKED
14	6		414.083	-506.403	-414.083	0	LOCKED	LOCKED
15	7		-336.115	429.105	336.115	0	LOCKED	LOCKED
16	8		499.289	-615.15	-499.289	0	LOCKED	LOCKED
17	1	N4	-213.014	271.868	-213.014	0	LOCKED	LOCKED
18	2		-576.997	732.448	-576.997	0	LOCKED	LOCKED
19	3		-642.232	816.791	-642.232	0	LOCKED	LOCKED
20	4		-15.679	33.6	-15.679	0	LOCKED	LOCKED
21	5		-421.321	537.852	-421.321	0	LOCKED	LOCKED
22	6		414.083	-506.403	414.083	0	LOCKED	LOCKED
23	7		-336.115	429.105	-336.115	0	LOCKED	LOCKED
24	8		499.289	-615.15	499.289	0	LOCKED	LOCKED
25	1	N5	213.014	271.868	-213.014	0	LOCKED	LOCKED
26	2		576.997	732.448	-576.997	0	LOCKED	LOCKED
27	3		642.232	816.791	-642.232	0	LOCKED	LOCKED
28	4		15.679	33.6	-15.679	0	LOCKED	LOCKED
29	5		421.321	537.852	-421.321	0	LOCKED	LOCKED
30	6		-414.083	-506.403	414.083	0	LOCKED	LOCKED
31	7		336.115	429.105	-336.115	0	LOCKED	LOCKED

Joint Reactions (By Item) (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
32	8		-499.289	-615.15	499.289	0	LOCKED	LOCKED
33	1	N2	NC	NC	NC	LOCKED	LOCKED	LOCKED
34	2		NC	NC	NC	LOCKED	LOCKED	LOCKED
35	3		NC	NC	NC	LOCKED	LOCKED	LOCKED
36	4		NC	NC	NC	LOCKED	LOCKED	LOCKED
37	5		NC	NC	NC	LOCKED	LOCKED	LOCKED
38	6		NC	NC	NC	LOCKED	LOCKED	LOCKED
39	7		NC	NC	NC	LOCKED	LOCKED	LOCKED
40	8		NC	NC	NC	LOCKED	LOCKED	LOCKED
41	1	Totals:	0	1087.471	0			
42	2		0	2929.792	0			
43	3		0	3267.165	0			
44	4		0	134.399	0			
45	5		0	2151.409	0			
46	6		0	-2025.612	0			
47	7		0	1716.421	0			
48	8		0	-2460.6	0			
49	1	COG (in):	X: 48	Y: 6.529	Z: 48			
50	2		X: 48	Y: 6.565	Z: 48			
51	3		X: 48	Y: 6.552	Z: 48			
52	4		X: 48	Y: 3.889	Z: 48			
53	5		X: 48	Y: 6.528	Z: 48			
54	6		X: 48	Y: 6.814	Z: 48			
55	7		X: 48	Y: 6.527	Z: 48			
56	8		X: 48	Y: 6.764	Z: 48			

CLS ENGINEERING INC.	Client: Bristolite Skylights	Date:	4/5/2017	
	Project: College of Marin	Project #:	Q1703001	10
	Location: Novato, CA	Designed By:	CLS	

Check Adequacy of 3" Hip Rafter

•6063-T6 - ASD

Bending

$Mu = wl^2/8 =$ 6,931 in-#

Member Span = 5.92 ft

slenderness (s) = $\frac{2LbSc}{\sqrt{(Iy\ J)}}$ ⟶ 558.4

Fb if S < 130 = 15.000 ksi

Design Fb = 13.392 ksi

Fb if 130 < S < 2400 = 13.392 ksi

Fb if S > 2400 = 42.265 ksi

fb = Mu / Sz = 5,549.2 psi

fb / Fb = **0.41** Bending OK

Axial Compression

Pu = 1102 lbs

r_z = 1.163 in

kl/r = 67.20

$F_{a\ (kl/r < 78)}$ = 9.227 ksi

$F_{a\ (kl/r > 78)}$ = 11.316 ksi

Design Fa = 9.227 ksi

fa = Pu / A = 697 psi

fa / Fa = **0.08** Axial OK

Combined Bending + Axial = fb/Fb + fa/Fa = **0.49** Member OK

Deflection

$\Delta = 5wl^4 / 384EI =$ 0.362

Lu = 71.04 inches

Δ= L/ 196 Deflection OK

Shear

Vu = wl/2 = 527.0 lbs

s = h/t = 25.00

$F_{v\ (S < 39)}$ = 8.500 ksi

$F_{v\ (39 < S < 77)}$ = 9.525 ksi

$F_{v\ (S > 77)}$ = 61.920 ksi

Design Fv = 8.500 ksi

fv = Vu / A = 333 psi

fv / Fv = **0.04** Shear OK

Rafter Properties 3" Hip Rafter		
Ax =	1.5810	in^2
b =	1.7500	in
d =	3.0000	in
Tb =	0.1200	in
Td =	0.1200	in
Iz =	2.1380	in^4
Iy =	1.0100	in^4
Ix =	0.1000	in^4
Sz =	1.2490	in^3
Sy =	0.8080	in^3

CLS ENGINEERING INC.	Client: Bristolite Skylights	Date:	4/5/2017	
	Project: College of Marin	Project #:	Q1703001	//
	Location: Novato, CA	Designed By:	CLS	

Check Curb Connections @ Hips

0.6DL + WL-

Horizontal Loading: Actual Load = 706 #

Fasteners Used to Resist Loading: 1/4" x 2" Lag screws to attach frame to wood curb
Quantity of Fasteners: 4 - 12" o.c. spacing + (4) at hips
Tension Capacity of Fastener: 450 # = 225#/in x 1.6 LDF x 1.25"
Total Tension Capacity of Fastener: 1800 #

$\frac{\text{Actual}}{\text{Allowable}}$ = **0.39** **Connection Adequate**

Vertical Loading: Actual Load = 0 #

- Skylight bears directly on wood curb to resist vertical loading.
- Curb designed by others

Uplift Loading: Actual Load = 615 #

Fasteners Used to Resist Loading: 1/4" x 2" Lag screws to attach frame to wood curb
Quantity of Fasteners: 4 - 12" o.c. spacing + (4) at hips
Shear/Bearing Capacity of Fastener: 192 # = 120# x 1.6 LDF
Total Shear/Bearing Capacity of Fastener: 768 #

$\frac{\text{Actual}}{\text{Allowable}}$ = **0.80** **Connection Adequate**

Combined Shear & Tension Forces: $(Tu / Tn)^{5/3} + (Vu / Vn)^{5/3}$ = **0.90** **Connection Adequate**

Check Rafter Attachment to Frame & Peak

Horizontal Load= 706 #
Vertical Load = 615 #

- Weld the hip rafters to the frame with 1/8" fillet weld (1100 filler or better); or together at peak

Weld Length = 5.5 inches minimum

V_{weld} = 7500 psi x 0.125" x 0.707 x 4" x 1/1.95 = 1869 lbs

$V_{base\ metal}$ = 2800 psi x 0.125" x 4" = 1925 lbs

Utilization: 908# / 1869# + 817# / 1869# = **0.71** **Connection Adequate**

Client: Bristolite Skylights		Date:	4/5/2017
Project: College of Marin		Project #:	Q1703001
Location: Novato, CA		Designed By:	CLS

Check Curb Connections @ Hips

DL + 0.75Lr + 0.75WL+

Horizontal Loading: Actual Load = 908 #

Fasteners Used to Resist Loading: 1/4" x 2" Lag screws to attach frame to wood curb
Quantity of Fasteners: 4 - 12" o.c. spacing + (4) at hips
Tension Capacity of Fastener: 450 # = 225#/in x 1.6 LDF x 1.25"
Total Tension Capacity of Fastener: 1800 #

$\frac{\text{Actual}}{\text{Allowable}}$ = **0.50** **Connection Adequate**

Vertical Loading: Actual Load = 817 #

- Skylight bears directly on wood curb to resist vertical loading.
- Curb designed by others

Uplift Loading: Actual Load = 0 #

Fasteners Used to Resist Loading: 1/4" x 2" Lag screws to attach frame to wood curb
Quantity of Fasteners: 4 - 12" o.c. spacing + (4) at hips
Shear/Bearing Capacity of Fastener: 192 # = 120# x 1.6 LDF
Total Shear/Bearing Capacity of Fastener: 768 #

$\frac{\text{Actual}}{\text{Allowable}}$ = **0.00** **Connection Adequate**

Combined Shear & Tension Forces: $(Tu / Tn)^{5/3} + (Vu / Vn)^{5/3}$ = **0.32** **Connection Adequate**

Check Rafter Attachment to Frame & Peak

Horizontal Load= 908 #
Vertical Load = 817 #

- Weld the hip rafters to the frame with 1/8" fillet weld (1100 filler or better); or together at peak

Weld Length = 5.5 inches minimum

V_{weld} = 7500 psi x 0.125" x 0.707 x 5.5" x 1/1.95 = 1869 lbs

$V_{base\ metal}$ = 2800 psi x 0.125" x 5.5" = 1925 lbs

Utilization: 908# / 1869# + 817# / 1869# = **0.92** **Connection Adequate**

CLS ENGINEERING INC.	Client: Bristolite Skylights	Date: 4/5/2017	13
	Project: College of Marin	Project #: Q1703001	
	Location: Novato, CA	Designed By: CLS	

Check Alum. Clamping Bars @Hip Rafters

Uplift Load=	26.7	psf	Fb Cap =	15000	psi
Trib. Length =	6	feet	Cap Thickness =	0.094	inches
Uniform Load (W)=	160.2	plf	Lever Arm (a) =	1.5	inches
			Effective Length =	12	inches

Mu =Wa = 240.3 in-#

Mn = Fb S = 265.08 in-# ✓

Mu / Mn = 0.91 Bending OK

Check Fasteners

- Use #14 screws to attach compression cap to rafters @ 9" o.c.

- Tension Capacity of #14 Fasteners = 351 #

Actual / Allowable =

- Actual Tension per Fasteners = 160.2 # ✓

Actual Tension / Allowable Tension = 0.46 Fasteners OK

Check Alum Perimeter Clamp Angle @ Frame

Uplift Load=	26.7	psf	Fb Cap =	15000	psi
Trib. Length =	2	feet	Cap Thickness =	0.06	inches
Uniform Load (W)=	53.4	plf	Lever Arm (a) =	0.75	inches
			Effective Length =	12	inches

Mu =Wa = 40.05 in-#

Mn = Fb S = 54 in-# ✓

Mu / Mn = 0.74 Bending OK

Check Fasteners

- Use #14 screws to attach perimeter clamp angle to frame @ 9" o.c.

- Tension Capacity of #14 Fasteners = 351 #

- Actual Tension per Fasteners = 53.4 # ✓

Actual Tension / Allowable Tension = 0.15 Fasteners OK

CLS ENGINEERING INC.	**Client:** Bristolite Skylights	Date:	4/5/2017	14
	Project: College of Marin	Project #:	Q1703001	
	Location: Novato, CA	Designed By:	CLS	

Check Seismic

W_p = Total Panel Weight
= 12 PSF x 8' x 1.7' x 0.5 x 4
= 330 pounds / pyramid unit
=
=

S_{DS} =	1	g
I_p =	1.25	
R_p =	1	
a_p =	1.25	
z =	40	feet
h =	40	feet

$$F_p = \frac{0.4 a_p S_{DS}}{W_p \; R_p/Ip}(1 + 2*(z/h)) = \mathbf{619} \; \#$$

$$F_{p\,MAX} = 1.6 S_{DS} W_p Ip = \mathbf{660} \; \#$$

$$F_{p\,MIN} = 0.3 S_{DS} W_p Ip = \mathbf{124} \; \#$$

Design Fp = **619** # Total

Design Fp per rafter = Total Fp / 2 sides ✓
= **309.38** # / side

- Conservatively assume that the vertical shear = horizontal shear

- At the Curb, the frame is attached to wood framing with 1/4" Lag Screws @ 12" o.c. + (4) @ hips
  - Shear Capacity of Lags = 120# x 1.6 LDF x 8 Lags min/side= 1536# > 310# ✓
  - Tension/Withdrawal Capacity of Lags = 225#/in x 1.6 LDF x 1" minx 8 lags min/side= 2880# > 310#

Utilization Ratio: $(310\# / 1536\#)^{5/3} + (310\# / 1536\#)^{5/3}$ = 0.14 ✓ **Connection Adequate**

TABLE 11

STAINLESS STEEL - Alloy Groups 1, 2 and 3, Condition CW

Nominal Thread Diameter & Thread/Inch	D Nominal Thread Diameter (Inch)	A(S) Tensile Stress Area (Sq. In.)	A(R) Thread Root Area (Sq. In.)	Allowable Tension (Pounds)	Allowable Shear		Bearing (Pounds)			Minimum Material Thickness to Equal Tensile Capacity of Fastener (In.)		
					Single (Pounds)	Double (Pounds)	1/8" St A36	1/8" Al. 6063-T5	1/8" Al. 6063-T6	A36	6063-T5	6063-T6
#6-32	0.1380	0.0091	0.0078	364	180	360	1201	276	414	0.126	0.274	0.198
#8-32	0.1640	0.0140	0.0124	560	286	573	1427	328	492	0.162	0.368	0.261
#10-24	0.1900	0.0175	0.0152	700	351	702	1653	380	570	0.170	0.372	0.267
#12-24	0.2160	0.0242	0.0214	968	494	988	1879	432	648	0.200	0.450	0.321
1/4-20	0.2500	0.0318	0.0280	1272	647	1293	2175	500	750	0.226	0.541	0.360
5/16-18	0.3125	0.0524	0.0469	2096	1083	2166	2719	625	938	0.284	- - -	0.459
3/8-16	0.3750	0.0775	0.0699	3100	1614	3229	3262	750	1125	0.341	- - -	0.553
7/16-14	0.4375	0.1063	0.0961	4252	2219	4439	3806	875	1313	0.395	- - -	0.642
1/2-13	0.5000	0.1419	0.1292	5676	2984	5967	4350	1000	1500	0.456	- - -	0.745
9/16-12	0.5625	0.1819	0.1664	7276	3843	7686	4894	1125	1688	0.510	- - -	0.836
5/8-11	0.6250	0.2260	0.2071	9040	4783	9566	5437	1250	1875	0.563	- - -	0.923
3/4-10	0.7500	0.3345	0.3091	11289	6023	12046	6525	1500	2250	0.590	- - -	0.963
7/8-9	0.8750	0.4617	0.4286	15582	8352	16703	7612	1750	2625	0.686	- - -	1.123
1-8	1.0000	0.6057	0.5630	20442	10970	21941	8700	2000	3000	0.778	- - -	1.276

	DIAMETER	
	Up Thru 5/8"	3/4" and Over
F_u (Min. Ultimate Tensile Strength)	110,000 psi	85,000 psi
F_y (Min. Tensile Yield Strength)	65,000 psi	45,000 psi
F_t (Allowable Tensile Stress)	40,000 psi	33,750 psi
F_s (Allowable Shear Stress)	23,094 psi	19,486 psi

$$A(R) = 0.7854\left[D - \frac{1.2269}{N}\right]^2$$

$$A(S) = 0.7854\left[D - \frac{0.9743}{N}\right]^2$$

For Diameters 3/4" and Over:

$F_t = 0.75F_y$

Allowable tension $= 0.75F_y[A(S)]$

$F_s = \frac{0.75}{\sqrt{3}}F_y$

Allowable shear (Single) $= \frac{0.75}{\sqrt{3}}F_y[A(R)]$

For Diameters Up Thru 5/8":

$F_t = 0.40F_u$

Allowable tension $= 0.40F_u[A(S)]$

$F_s = \frac{0.40}{\sqrt{3}}F_u$

Allowable shear (Single) $= \frac{0.40}{\sqrt{3}}F_u[A(R)]$

In Tables 9 thru 15, for Group Type and Condition Definitions see pages 21 and 22.

TABLE 12

STAINLESS STEEL - Alloy Groups 1, 2 and 3, Condition SH

Nominal Thread Diameter & Thread/Inch	D Nominal Thread Diameter (Inch)	A(S) Tensile Stress Area (Sq. In.)	A(R) Thread Root Area (Sq. In.)	Allowable Tension (Pounds)	Allowable Shear		Bearing (Pounds)			Minimum Material Thickness to Equal Tensile Capacity of Fastener (In.)	
					Single (Pounds)	Double (Pounds)	A36	1/8" Al. 6063-T5	6063-T6	A36	6063-T6
#6-32	0.1380	0.0091	0.0078	437	216	432	1201	276	414	0.144	0.231
#8-32	0.1640	0.0140	0.0124	672	344	687	1427	328	492	0.188	0.308
#10-24	0.1900	0.0175	0.0152	840	421	842	1653	380	570	0.195	0.313
#12-24	0.2160	0.0242	0.0214	1162	593	1186	1879	432	648	0.232	0.377
1/4-20	0.2500	0.0318	0.0280	1526	776	1552	2175	500	750	0.261	0.422
5/16-18	0.3125	0.0524	0.0469	2515	1300	2599	2719	625	938	0.330	0.539
3/8-16	0.3750	0.0775	0.0699	3720	1937	3874	3262	750	1125	0.396	0.651
7/16-14	0.4375	0.1063	0.0961	5102	2663	5326	3806	875	1313	0.460	0.756
1/2-13	0.5000	0.1419	0.1292	6811	3580	7161	4350	1000	1500	0.532	0.878
9/16-12	0.5625	0.1819	0.1664	8731	4611	9223	4894	1125	1688	0.596	0.985
5/8-11	0.6250	0.2260	0.2071	10848	5739	11479	5437	1250	1875	0.657	1.089
3/4-10	0.7500	0.3345	0.3091	14718	7852	15704	6525	1500	2250	0.739	1.225
7/8-9	0.8750	0.4617	0.4286	20315	10888	21776	7612	1750	2625	0.860	1.431
1-8	1.0000	0.6057	0.5630	26651	14302	28604	8700	2000	3000	0.977	1.626

	DIAMETER	
	Up Thru 5/8"	3/4" and Over
F_u (Min. Ultimate Tensile Strength)	120,000 psi	110,000 psi
F_y (Min. Tensile Yield Strength)	95,000 psi	75,000 psi
F_t (Allowable Tensile Stress)	46,000 psi	44,000 psi
F_s (Allowable Shear Stress)	27,713 psi	25,403 psi

$$A(R) = 0.7854\left[D - \frac{1.2269}{N}\right]^2$$

$$A(S) = 0.7854\left[D - \frac{0.9743}{N}\right]^2$$

$F_t 0.40F_u$

Allowable tension $0.40F_u[A(S)]$

$F_s \frac{0.40}{\sqrt{3}}F_u$

Allowable shear (Single) $\frac{0.40}{\sqrt{3}}F_u[A(R)]$

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LAG SCREWS

Table 12K LAG SCREWS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3,4]

for sawn lumber or SCL with ASTM A653, Grade 33 steel side plate (for t_s<1/4") or ASTM A 36 steel side plate (for t_s=1/4")
(tabulated lateral design values are calculated based on an assumed length of lag screw penetration, p, into the main member equal to 8D)

Side Member Thickness	Lag Screw Diameter	G=0.67 Red Oak		G=0.55 Mixed Maple Southern Pine		G=0.5 Douglas Fir-Larch		G=0.49 Douglas Fir-Larch (N)		G=0.46 Douglas Fir(S) Hem-Fir(N)		G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.37 Redwood (open grain)		G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods		G=0.35 Northern Species	
t_s	D	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$
in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0.075	1/4	170	130	160	120	150	110	150	110	150	100	140	100	140	100	130	90	130	90	130	90
(14 gage)	5/16	220	160	200	140	190	130	190	130	190	130	180	120	180	120	170	110	170	110	160	100
	3/8	220	160	200	140	200	130	190	130	190	120	180	120	180	120	170	110	170	100	170	100
0.105	1/4	180	140	170	130	160	120	160	120	160	110	150	110	150	110	140	100	140	100	140	90
(12 gage)	5/16	230	170	210	150	200	140	200	140	190	130	190	130	190	120	180	110	170	110	170	110
	3/8	230	160	210	140	200	140	200	130	200	130	190	120	190	120	180	110	180	110	170	110
0.120	1/4	190	150	180	130	170	120	170	120	160	120	160	110	160	110	150	100	150	100	140	100
(11 gage)	5/16	230	170	210	150	210	140	200	140	200	140	190	130	190	130	180	120	180	120	180	110
	3/8	240	170	220	150	210	140	210	140	200	130	200	130	190	120	180	110	180	110	180	110
0.134	1/4	200	150	180	140	180	130	170	130	170	120	160	120	160	110	150	110	150	100	150	100
(10 gage)	5/16	240	180	220	160	210	150	210	140	200	140	200	130	200	130	190	120	180	120	180	120
	3/8	240	170	220	150	220	140	210	140	210	140	200	130	200	130	190	120	190	120	180	110
0.179	1/4	220	170	210	150	200	150	200	140	190	140	190	130	190	130	180	120	170	120	170	120
(7 gage)	5/16	260	190	240	170	230	160	230	160	230	150	220	150	220	150	210	130	200	130	200	130
	3/8	270	190	250	170	240	160	240	160	230	150	220	140	220	140	210	130	210	130	200	130
0.239	1/4	240	180	220	160	210	150	210	150	200	140	190	140	190	130	180	120	180	120	180	120
(3 gage)	5/16	300	220	280	190	270	180	260	180	260	170	250	160	250	160	230	150	230	150	230	140
	3/8	310	220	280	190	270	180	270	180	260	170	250	160	250	160	240	140	230	140	230	140
	7/16	420	290	390	260	380	240	370	240	360	230	350	220	350	220	330	200	330	200	320	190
	1/2	510	340	470	300	460	290	450	280	440	270	430	260	420	260	400	240	400	230	390	230
	5/8	770	490	710	430	680	400	680	400	660	380	640	370	630	360	600	330	590	330	580	320
	3/4	1110	670	1020	590	980	560	970	550	950	530	920	500	910	500	860	450	850	450	840	440
	7/8	1510	880	1390	780	1330	730	1320	710	1280	690	1250	650	1230	650	1170	590	1160	590	1140	570
	1	1940	1100	1780	960	1710	910	1700	890	1650	860	1600	820	1590	810	1500	740	1480	730	1460	710
1/4	1/4	240	180	220	160	210	150	210	150	200	140	200	140	190	130	180	120	180	120	180	120
	5/16	310	220	280	200	270	180	270	180	260	170	250	170	250	160	230	150	230	150	230	140
	3/8	320	220	290	190	280	180	270	180	270	170	260	160	250	160	240	150	240	140	230	140
	7/16	480	320	440	280	420	270	420	260	410	250	390	240	390	230	370	220	360	210	360	210
	1/2	580	390	540	340	520	320	510	320	500	310	480	290	480	290	460	270	450	260	440	260
	5/8	850	530	780	470	750	440	740	440	720	420	700	400	690	400	660	370	650	360	640	350
	3/4	1200	730	1100	640	1060	600	1050	590	1020	570	990	540	980	530	930	490	920	480	900	470
	7/8	1600	930	1470	820	1410	770	1400	750	1360	720	1320	690	1310	680	1240	630	1220	620	1200	600
	1	2040	1150	1870	1000	1800	950	1780	930	1730	900	1680	850	1660	840	1570	770	1550	760	1530	740

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "reduced body diameter" lag screws (see Appendix Table L2) inserted in side grain with screw axis perpendicular to wood fibers; screw penetration, p, into the main member equal to 8D; dowel bearing strengths, F_e, of 61,850 psi for ASTM A653, Grade 33 steel and 87,000 psi for ASTM A36 steel and screw bending yield strengths, F_{yb}, of 70,000 psi for D = 1/4", 60,000 psi for D = 5/16", and 45,000 psi for D ≥3/8".
3. Where the lag screw penetration, p, is less than 8D but not less than 4D, tabulated lateral design values, Z, shall be multiplied by p/8D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. The length of lag screw penetration, p, not including the length of the tapered tip, E (see Appendix Table L2), of the lag screw into the main member shall not be less than 4D. See 12.1.4.6 for minimum length of penetration, p_{min}.

(17)

Table 12.2A Lag Screw Reference Withdrawal Design Values, W[1]

Tabulated withdrawal design values (W) are in pounds per inch of thread penetration into side grain of wood member. Length of thread penetration in main member shall not include the length of the tapered tip (see 12.2.1.1).

Specific Gravity, G^2	Lag Screw Diameter, D										
	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"
0.73	397	469	538	604	668	789	905	1016	1123	1226	1327
0.71	381	450	516	579	640	757	868	974	1077	1176	1273
0.68	357	422	484	543	600	709	813	913	1009	1103	1193
0.67	349	413	473	531	587	694	796	893	987	1078	1167
0.58	281	332	381	428	473	559	641	719	795	869	940
0.55	260	307	352	395	437	516	592	664	734	802	868
0.51	232	274	314	353	390	461	528	593	656	716	775
0.50	225	266	305	342	378	447	513	576	636	695	752
0.49	218	258	296	332	367	434	498	559	617	674	730
0.47	205	242	278	312	345	408	467	525	580	634	686
0.46	199	235	269	302	334	395	453	508	562	613	664
0.44	186	220	252	283	312	369	423	475	525	574	621
0.43	179	212	243	273	302	357	409	459	508	554	600
0.42	173	205	235	264	291	344	395	443	490	535	579
0.41	167	198	226	254	281	332	381	428	473	516	559
0.40	161	190	218	245	271	320	367	412	455	497	538
0.39	155	183	210	236	261	308	353	397	438	479	518
0.38	149	176	202	227	251	296	340	381	422	461	498
0.37	143	169	194	218	241	285	326	367	405	443	479
0.36	137	163	186	209	231	273	313	352	389	425	460
0.35	132	156	179	200	222	262	300	337	373	407	441
0.31	110	130	149	167	185	218	250	281	311	339	367

1. Tabulated withdrawal design values, W, for lag screw connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Specific gravity, G, shall be determined in accordance with Table 12.3.3A.

12.2.3.2 For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of fastener penetration from 12.2.3.1 shall be multiplied by the length of fastener penetration, p_t, into the wood member.

12.2.3.3 The reference withdrawal design value, in lbs/in. of penetration, for a single post-frame ring shank nail driven in the side grain of the main member, with the nail axis perpendicular to the wood fibers, shall be determined from Table 12.2D or Equation 12.2-4, within the range of specific gravities and nail diameters given in Table 12.2D. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 1800\ G^2\ D \qquad (12.2\text{-}4)$$

12.2.3.4 For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of ring shank penetration from 12.2.3.3 shall be multiplied by the length of ring shank penetration, p_t, into the wood member.

12.2.3.5 Nails and spikes shall not be loaded in withdrawal from end grain of wood (C_{eg}=0.0).

12.2.3.6 Nails, and spikes shall not be loaded in withdrawal from end-grain of laminations in cross-laminated timber (C_{eg}=0.0).

12.2.4 Drift Bolts and Drift Pins

Reference withdrawal design values, W, for connections using drift bolt and drift pin connections shall be determined in accordance with 11.1.1.3.