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Bid # 2049 L-Tower Building Seismic and Code Upgrades
Addendum # 4
September 13, 2016

To: All Prospective Bidders

THE FOLLOWING REVISIONS AND/OR CLARIFICATIONS SHALL BE MADE TO THE BIDDING REQUIREMENTS AND CONTRACT DOCUMENTS. REVISE AND AMEND THE DOCUMENTS FOR THE ABOVE NAMED PROJECT IN ACCORDANCE WITH THIS ADDENDUM. THE BID SHALL REFLECT THESE ADDENDUM CHANGES AND EACH BIDDER SHALL MAKE REFERENCE IN
THEIR BID TO THIS ADDENDUM ALL BIDDING REQUIREMENTS AND CONTRACT DOCUMENTS SHALL APPLY TO THIS ADDENDUM AS ORIGINALLY INDICATED IN THE APPLICABLE PORTIONS OF THE CONTRACT DOCUMENTS, UNLESS OTHERWISE MODIFIED BY THIS ADDENDUM.

Acknowledge receipt of this Addendum # 4 in the space provided on Bid Form. Failure to do so may result in the bid being deemed non-responsive.

The Addendum consists of the following changes:

1. **ADMINISTRATIVE ITEMS; Bidding Documents:**

   1.1. ADD: Add the attached document dated September 9, 2016, titled “Addendum No. 4”. This document includes changes to the Specifications Table of Contents, Changes to the Specifications, Added Specification sections, Additional Drawings, and answers to Pre-Bid Clarifications:.

Date: September 9, 2016

ADDENDUM 4

To Project Bidding Documents for:

"L" TOWER BUILDING **W+W** Proj. No. 15003.00
SEISMIC AND CODE UPGRADES DSA Appl. No. 03-116761
RIO HONDO COLLEGE DSA File No.19-C12
3600 Workman Mill Road
Whittier, CA 90601

Owner:
RIO HONDO COMMUNITY COLLEGE DISTRICT
3600 Workman Mill Road
Whittier, CA 90601

Architect:
Westberg + White Architects, Inc.
14471 Chambers Road, Suite 210
Tustin, CA 92780
714/508-1780

TO: PROSPECTIVE BIDDERS

This Addendum forms part of Contract Documents and modifies original Bidding Documents dated June 7, 2016. Acknowledge receipt of this Addendum in space provided on Bid Form. Failure to acknowledge may subject Bidder to disqualification.

CHANGES TO TABLE OF CONTENTS

1. Revise Table of Contents as follows:
   a. Insert following:
      "23 0900 Commissioning of Smoke Control System "
      "23 0923 Direct Digital Control System for HVAC"
      "23 3616 Single Duct Air Terminal"
      "23 8126 Variable Refrigerant Flow System"
   b. Delete following:
      "23 8126 Split Air Conditioning System"

2. Table of Contents is not reissued.

CHANGES TO SPECIFICATIONS BY DESCRIPTION:

1. **Section 08 8000 – Glazing:**
   a. Article 3.06, paragraph E – Glass Type G5, Item 1 c:

      Revised term "Subdued Gray" to read: "White"

   b. Section 08 8000 is not reissued.

2. **Section 09 5100 – Acoustical Ceilings:**

a. Article 2.02, paragraph B – Revise as follows:

"B. 24 inch x 48 inch Module Ceiling System:
1. Acoustical Ceiling Panel **ACP-1**
a. ASTM E 1264, Type III, Form 2, Pattern C E
b. Thickness: 5/8 inch
c. Edge: Square.
d. Light Reflectance: 0.85 minimum, complying with ASTM E 1477.
e. CAC: Minimum 35, UL Classified, complying with ASTM E 1414.
f. Class: UL Class A, in accordance with ASTM E 1264.
g. NRC: Minimum 0.50, UL Classified, complying with ASTM C 423.
i. Color: White.
j. Recycled Content: Minimum 36 percent.
k. Mold and Mildew Resistance: Panels and faces shall be treated with biocide paint additive to inhibit mold and mildew or anti-microbial solution.
l. Product: Armstrong Item No. 1729, Fine Fissured mineral fiber ceiling board with Humigard Plus coating."

b. Article 2.02, paragraph C, Item 1:

Revise "Suprafine XL 9/16 inch" to read: "Prelude 15/16 inch"

c. Article 2.02 – Insert following:

"D. 48 inch x 48 inch Module Ceiling System:
1. Acoustical Ceiling Panel **ACP-2**
a. ASTM E 1264, Type XII, Form 2, Pattern E
b. Thickness: 1 inch
c. Edge: Square.
d. Light Reflectance: 0.90 minimum, complying with ASTM E 1477.
e. CAC: N/A.
f. Class: UL Class A, in accordance with ASTM E 1264.
g. NRC: Minimum 0.95, UL Classified, complying with ASTM C 423.
i. Color: White.
j. Recycled Content: Minimum 50 percent.
k. Mold and Mildew Resistance: Panels and faces shall be treated with biocide paint additive to inhibit mold and mildew or anti-microbial solution.
l. Product: Armstrong Item No. 3160, Optima mineral fiber, fine texture ceiling board with Humigard Plus coating.

E. Suspension System:
1. Suspension System Name: Prelude XL Fire Guard 15/16 inch by Armstrong.
2. Fire Class: Class A.
3. Duty: Heavy Duty.
4. Color: White.

F. 24 inch x 24 inch Module Ceiling System:
   1. Acoustical Ceiling Panel **ACP-3**
      a. ASTM E 1264, Type XII, Form 2, Pattern E
      b. Thickness: 3 inch
      c. Edge: Square.
      d. Light Reflectance: 0.90 minimum, complying with ASTM E 1477.
      e. CAC: N/A.
      f. Class: UL Class A, in accordance with ASTM E 1264.
      g. NRC: Minimum 0.90, UL Classified, complying with ASTM C 423.
      i. Color: White.
      j. Recycled Content: Minimum 50 percent.
      k. Mold and Mildew Resistance: Panels and faces shall be treated with biocide paint additive to inhibit mold and mildew or anti-microbial solution.
      l. Product: Armstrong Item No. 3150, Optima mineral fiber, fine texture ceiling board with Humigard Plus coating."

G. Suspension System:
   1. Suspension System Name: Prelude XL Fire Guard 15/16 inch by Armstrong.
   2. Fire Class: Class A.
   3. Duty: Heavy Duty.
   4. Color: White."

d. Article 2.02 –

   Revise paragraph "D" to paragraph "H"

   Revise paragraph "E" to paragraph "I"

   Revise paragraph "F" to paragraph "J"

e. Section 09 5100 is not reissued.

3. **Section 23 0519 – Meters and Gages**
   a. Delete Section 23 0519 in its entirety and replace with revised Section 23 0519.

4. **Section 23 0900 – Commissioning of Smoke Control System**
   a. Insert new Section 23 0900.

5. **Section 23 0923 – Direct Digital Control System for HVAC**
   a. Insert new Section 23 0923

6. **Section 23 3616 – Single Duct Air Terminal**
   a. Insert new Section 23 3616

7. **Section 23 7513 – Air Handling Units**
   a. Delete Section 23 7513 in its entirety and replace with revised Section 23 7513

8. **Section 23 8126 – Split Air Conditioning System**
   a. Delete Section 23 8126 – Split Air Conditioning Sysem in its entirety and replace with new Section 23 8216 – Variable Refrigerant Flow System.

CHANGES TO DRAWINGS:

CIVIL

1. **SHEET C4.0 – UTILITY PLAN**
   a. Added utility and construction notes and adjusted callouts on plan.

2. **SHEET C5.1 – GRADING PLAN**
   a. Adjusted sheet callout for section C to Sheet C5.2.

3. SHEET C6.0 – DETAIL SHEET
   a. Added water line crossing detail and edited pipe trenching and bedding detail.

ARCHITECTURAL

1. **SHEET A702 – WINDOW SCHEDULE**
   a. Revised note on glass type schedule.
   b. Revised glass types for window types B and C.

2. **SHEET A704 – WINDOW SCHEDULE**
   a. Labeled glass colors on window types P,Q and R.

3. **SHEET A710 – FINISH SCHEDULE**
   a. Revised various colors throughout sheet.

4. **SHEET A711 – COLOR SCHEDULE**
   a. Revised various colors throughout sheet.

5. **SHEET A950 – PATTERN PLANS**
   a. Added paint call out, Note and revised view title

STRUCTURAL

1. **SHEET S105 – TYPICAL STEEL SECTIONS AND DETAILS**
   a. Clarification notes added to detail 7/S105.

2. **SHEET S203 – SECOND FLOOR FRAMING PLAN**
   a. Lines and Designations for FRP wrapping added to beams on lines 19a and 20 (6 locations) to match tables on Sheet S513.

3. **SHEET S206 – FIFTH FLOOR FRAMING PLAN**
   a. Lines and Designations for FRP wrapping added to beams on lines 19a and 20 (2 locations) to match tables on sheet S513.

4. **SHEET S207 – ROOF FRAMING PLAN**
   a. Lines and Designations for FRP wrapping deleted for beams between lines 19a and 20 (4 locations) to match tables on sheet S513.

5. **SHEET S207A – MECHANICAL EQUIPMENT LAYOUT PLAN AT ROOF**
   a. Reference to AHU-2 roof attachment detail corrected.

6. **SHEET S503 – SECTIONS AND DETAILS**
   a. Detail 4 marked as ‘NOT USED’.

7. **SHEET S513 – FRP DETAILS AND SCHEDULES**
   a. FRP wrapping tables modified in Details 1 and 13/S513

PRE-BID CLARIFICATIONS:

A. **Pre-Bid Clarification No. 1:**

Question:

1. The project currently includes specification section 08 7113 Automatic Door Operators, however none have been located on the drawings including the hardware groups, and the door schedule.
Please confirm there are no Automatic Door Operators on the project. If Automatic Door Operators are required, please revise the plans to indicate location and provide the required infrastructure including electrical and low voltage wiring.

W+W Response:
Disregard, No automatic door operator at Door 101-1 in this Phase.

B. **Pre-Bid Clarification No. 2:**

Question:

1. In reference to the "Schedule for FRP Wrapping on (E) Concrete Beams and Girders" (13/S513), verify below:
   a. Do all listed beams – other than beams listed on Grids A & D – require FRP Shear Strengthening "U" Wrap as noted and detailed on Detail 3/S513, Case 1 – Typical U.N.O.)? If so, how many layers and what type of FRP is required for the "U" wrap at each listed beam?

IDS Response:
The requirements for shear reinforcement will be provided in the updated Schedule 13/S513. No shear reinforcing is required other than those listed in the right-most column of the table.

Question:

   b. Moment Strengthening – Type 1 or 2 – is only required for beams when a design is listed in the schedule. Please verify.

IDS Response:
Confirmed.

Question:

   c. What does the "Designation" refer to in the schedule? For example, for the first beam listed in the schedule, a designation of "5G8" is given. What does this refer to? Is there a beam schedule provided with this designation? – in the new drawing set or an existing drawing set that refers to this designation? Please verify and provide existing structural drawings if required.

IDS Response:
"Designation" refers to the beam designations according to record drawings of the existing structure prepared by Hillman & Nowell, dated 1964. The beam schedules can be found on Sheets S213 and S214 in record drawings. Framing plans with beam designation call outs can be found on Sheets S201 to S205 in record drawings.

Question:

d. To quantify the FRP, the cross-section dimensions (depth below slab and width) are required for each beam. Please provide.

IDS Response:
See response to Item 1.c. above.

Question:

e. Moment Strengthening Type 1, for beams on Line A, refers to the FRP being 16" wide as applied to just one face of the beam. Is there enough depth to these beams that the 16" wide FRP can be applied? Are there any intersecting beams that may limit the FRP width for these beams?

IDS response:
See response to Item 1.c. above for information regarding the existing conditions. Typical beams on Line A are 38" deep and the outside face of the beams should be sufficient for the FRP as required. Field conditions should be verified in field before construction.

Question:

f. In regards to the listed beams in the schedule, the Keynote 2 listed on Plan Sheets S203 thru S207 do not coincide completely with the listed beams in the schedule. Does the schedule govern or does Keynote 2 on the plan sheets govern in regards to which beams require FRP?

IDS Response:
The schedules on S513 govern.

Question:

2. In reference to the "Schedule for FRP Wrapping on (E) Concrete Columns" (1/S513), verify below:

a. For all listed columns, what are the square cross-section dimensions of each column?

IDS response:
See response to Item 1.c. above for information regarding the existing conditions. Typical existing columns are 24 inches x24 inches.

C. **Pre-Bid Clarification No. 3:**

Question:

1. In reference to the FRP wrapping of concrete beams and columns please advise on the following:

a. Please note drawings S202-S207 indicate approximately 102 columns via typical note 1 to be wrapped with FRP.However the FRP column schedule on sheet S513 which details the specific number of layers and type of wrap only accounts for 80 columns. Please confirm the schedule is correct.

IDS Response:
Schedules on S513, shall govern. Plan key notes are intended to be a reference to the schedule where detailed information of FRP reinforcement is specified.

Question:

b. Also, the beam schedule shown on sheet S513 lists 28 beams but only provides specific coverage for 14 beams. In addition, Sheets S203-S207 account for 24 beams to have FRP via note 2.
Please advise if 14 beams are to be wrapped.

IDS Response:
See response to Item No. 1 above.

Question:

c. Finally, please advise how far up the beams the FRP is to wrap.

IDS Response:
Beam wraps shall be per Detail 3/S513. For "U" wraps as required per Schedule 13/S513, FRP shall be up the the under side of slab as shown in 3A/S513; for Type I moment strengthening, the bottom edge of the FRP on the side face(s) of the beam shall be at the bottom of the existing beam.

D. **Pre-Bid Clarification No. 4:**

Question:

1. The project currently includes specifications for intumescent paint 07 8123 however none can be located on the drawings. Please indicate location of steel to receive inumescent paint if any.

W+W Response:
Disregard. Fireproofing is not required on diagonal braces of BRB system.

E. **Pre-Bid Clarification No. 5:**

Question:

1. Ref. 17/S509; Which specification section specifies and includes the bearing plate assemblies?

IDS Response:
The bearing plate type is specified on the detail. " FLOURGOLD OR APPROVED EQUAL".

Question:

2. Ref. 7/S105; Please confirm both bolting AND welding is required at the W BM. To W BM connections.

IDS Response:
No, Welding is acceptable alternative to bolted connections.

Question:

3. Ref. 9/S514; The members at the Typical Support at Slab Opening are called-out as HSS6x6x1/2. These members are called-out as HSS6x6x1/4 on the plans. Which is correct?

IDS Response:
HSS6X6X1/4 is correct

F. **Pre-Bid Clarification No. 6:**

Question:

1. *Please advise if the manufactured Buckling Restrained Braces (BRB's) are to receive fireproofing. If so, please advise if fireproofing is to be cementitious or intumescent. Finally, please advise UL design and/or thickness of fireproofing to be applied to BRB's.*

W+W Response:
BRB Columns and Beams are protected. Fireproofing not required at diagonal braces.

G. **Pre-Bid Clarification No. 7:**

Question:

1. *Ref. 17/S511; What is the extent of and top detail at the C4x7.25 channel?*

IDS Response:
C4X7.25 will extend the full height of the penthouse wall.

Question:

2. *Ref. 19/A870; What is the top of parapet (coping) elevation?*

W+W Response:
Revise dimension on 19/A870 to be 4'-0"
Top of Parapet to be +86'-6"

Question:

3. *If the steel fabricator is AISC Certified, can they self-perform inspections and tests, thus eliminating the requirement to pay for cost of travel, housing, food and out of area premiums?*

W+W Response:
No – Not allowed by DSA.

Question:

4. *If not, please provide the daily cost of travel, housing, food, out of area premiums or other expenses so the steel fabricator may properly include these costs in his bid.*

W+W Response:
Refer to Del Terra for response and Division 00 requirements.

H. **Pre-Bid Clarification No. 8:**

Question:

1. *Details 3/S513 & 13/S513: For Case 1 in Detail 3, FRP shear strengthening "U" wraps are called out and it refers to the schedule in Detail 13. However, only moment strengthening is called out in the schedule. Please confirm that FRP shear strengthening is not needed or provide an FRP shear strengthening schedule.*

IDS Response:
The requirements for shear reinforcement are provided in the updated Schedule 13/S513. No shear reinforcing is required other than those listed in the right-most column of the table.

Question:

2. *Details 1/S202 & 1/S513: Detail 1/S202 shows columns D/20 and D/21 being wrapped with FRP, but they are not listed in the column strengthening schedule in Detail 1/S513. Please confirm that these columns are not to be wrapped or provide FRP materials, layers, strip widths, and spacing.*

IDS Response:
D/20 and D/21 are required to be wrapped with FRP per updated schedule 1/S513.

Question:

3. Details 1/S203, 1/S204, 1/S205, 2/S206, & 13/S513: The framing plans show beams C/19a-20 and B/19a-20 being wrapped with FRP, but they are not listed in the beam strengthening schedule in Detail 13/S513. Please confirm that these beams are not to be wrapped or provide FRP materials, layers, strip widths, and spacing.

IDS Response:
Schedules on S513, Addendum 4 shall govern. Plan key notes are intended to be a reference to the schedule where detailed information of FRP reinforcement is specified.

Question:

4. *Details 1/S207 & 13/S513: The framing plan shows beams D/19a-20, C/19a-20, B/19a-20, and A/19a-20 being wrapped with FRP, but they are not listed in the beam strengthening schedule in Detail 13/S513. Please confirm that these beams are not to be wrapped or provide FRP materials, layers, strip widths, and spacing.*

IDS Response:
Schedules on S513, Addendum 4 shall govern. Plan key notes are intended to be a reference to the schedule where detailed information of FRP reinforcement is specified.

Question:

5. *Details 1/S203 & 13/S513: Detail 13/S513 lists beams 19a/B-C and 20/B-C in the beam strengthening schedule, but these are not shown being wrapped with FRP in Detail 1/S203. Please confirm that these beams are to be wrapped with FRP.*

IDS Response:
Schedules on S513, Addendum #4 shall govern. Plan key notes are intended to be a reference to the schedule where detailed information of FRP reinforcement is specified.

Question:

6. *Detail 13/S513: The beam strengthening schedule lists various beams without FRP strengthening. Please confirm that these beams are not to be wrapped.*

IDS Response: Refer to response to Item No. 1 above. Addendum 4 shows the shear strengthening requirement of these beams.

Question:

7. *Specification Section 03 9300 3.01: It states that surfaces to receive FRP shall be abrasively prepared to achieve a 1/16" minimum amplitude. For horizontal column wrapping, this typically is not required in a contact-critical application. Please confirm what surface preparation will be needed for the concrete columns.*

IDS Response:
Surface abrasion for columns per referenced Spec. section is required. Column wrap is not only for concrete confinement purpose, it is also for shear strengthening where surface bonding is critical.

I. **Pre-Bid Clarification No. 9:**
Question:
1. Ref. 4/S503; Where does this section occur?

IDS Response:
Detail 4/S503 is not used. Will be eliminated in Addendum 4 drawings.

2. Ref. 13/S511; What is the spacing of the MC6x18 transverse supports beneath AHU-2?

IDS Response:
MC6X18 is continuous along the short edge of AHU-2.

J. **Pre-Bid Clarification No. 10:**
Question:
1. The reflected ceiling plans currently call out for three different sizes of acoustical ceiling tile however the specifications do not clearly indicate the required manufacture and model for each size of tile. Please provide spec for each size of tile 2x2, 2x4, and 4x4. Also, the tile that is specified for the 2x4 is Armstrong 1729 which is not recommended to go into a 9/16" grid. Please revisit the scope and confirm acoustical grid and tile spec for each size of tile.

W+W Response:
Refer to Specification Changes to Section 09 5100 in this Addendum.

K. **Pre-Bid Clarification No. 11:**
Question:
1. Drawing sheets AD101 and AD102 call out note D25 to sawcut and remove the existing exterior concrete walls at the 2nd,3rd,4th and 5th levels. Please confirm the existing walls are concrete panels and at each location made up of 3 individual concrete panels.

W+W Response:
See Structural Drawings for Detail. Panels are concrete and monolithic.

L. **Pre-Bid Clarification No. 12:**
Question:
Grading plan sheet C5.1 detail B calls out for section C/C4.1 at the new pedestrian ramp at Staff Lot B. However there is no sheet C4.1.
Please provide section and detail sheet.

K-H Response:
See Shweet C5.2. Revise Detail Reference

ATTACHMENTS:

Following specification sections are part of Addendum 4:

Specifications:

23 0519, 23 0900, 23 0923, 23 3616, 23 7513, and 23 8126

Following **r**evised previously issued Drawings, dated 9/9/2016, are part of Addendum 4. Drawings are 30 inches x 42 inches:

Civil Drawings:

C4.0, C5.1, and C6.0

Architectural Drawings:

A702, A704, A710, A 711, and A950

Structural Drawings:

S105, S203, S206, S207, S207A, S503, and S513

W+W Architects, Inc.

IDS Group

Pezeshki Engineering, Inc.

END OF ADDENDUM 4

SECTION 23 0519

METERS AND GAGES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following types of meters and gages:

1. Temperature gages and fittings.
2. Pressure gages and fittings.
3. Flow meters.

B. Meters and gages furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.02 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections and Section 23 0510 "Basic HVAC Requirements".

1. Product data for each type of meter and gage. Include scale range, ratings. Submit meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.
2. Maintenance data for each type of meter and gage for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 23 Section "Basic HVAC Requirements".

1.03 QUALITY ASSURANCE

A. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Liquid-In-Glass Thermometers:
   a. Marshalltown Instruments, Inc.
   b. Trerice (H.O.) Co.
   c. Weiss Instruments, Inc.
   d. Weksler Instruments Corp.
2. Thermometer Wells: Same as for thermometers.
3. Pressure Gages:
   a. Ametek, U.S. Gauge Div.
   b. Ashcroft Dresser Industries Instrument Div.
   c. Marsh Instruments Co., Unit of General Signal.
   d. Marshalltown Instruments, Inc.
   e. Trerice (H.O.) Co.

f. Weiss Instruments, Inc.
g. Weksler Instruments Corp.
h. WIKA Instruments Corp.

4. Pressure Gage Accessories: Same as for pressure gages.
5. Water Orifice-Type Measurement System:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT. Fluid Handling Div.
6. Calibrated Balance Valves
   a. Armstrong Pumps, Inc.
   b. Bell and Gossett, ITT, Fluid Handling Div.
7. Venturi-Type Flow Measurement System
   a. Armstrong Pumps, Inc.
   b. Barco Div., Marison Industries
   c. Gerand Engineering Co.
8. Test Plugs
   a. MG Piping Products Co.
   b. Peterson Equipment Co., Inc.
   c. Sisco, ASpedco, Inc. Co.
   d. Trerice (H.O.) Co.
   e. Watts Regulator Co.

2.02 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:

1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions
3. Heating Water: 30 to 300 deg with 2-degree scale divisions
4. Condenser Water: 0 to 160 deg F with 2-degree scale divisions
5. Chilled Water: 0 to 100 deg F with 2-degree scale divisions
6. Steam and Condensate: 50 to 400 Deg F with 2-degree scale divisions

2.03 LIQUID-IN-GLASS THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, mercury filled, magnifying lens.

D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.04 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.05 PRESSURE GAGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30" & 0-15 psi compound range; 1" and 1/2 psi graduations.
2. Chilled and heating water systems, except as otherwise indicated: 0-60 psi range, 1 psi graduation.
3. Condenser water system, except as otherwise indicated: (0-15); (0-30) psi range, (1/4 psi); (1/2 psi) graduation.
4. Except as otherwise indicated: 0-100 psi range, 1 psi graduation.
5. High temperature water system: 0-300 psi range, 2 psi graduations.

2.06 PRESSURE GAGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.07 FLOW METERS, GENERAL

A. Flow rate of elements and meters shall be same as connected equipment or system.

2.08 WAFER ORIFICE-TYPE FLOW ELEMENTS

A. Type: Differential-pressure wafer type orifice insert flow elements designed for installation between pipe flanges.

B. Construction: Cast-iron body, brass valves with integral check readout valves and caps, and calibrated nameplate. Elements pressure rated for 300 psig and 250 degree F.

2.09 CALIBRATED BALANCE VALVE

A. Type: Differential-pressure, ball type, adjustable orifice designed for installation in piping.

B. Construction: Bronze body/brass ball construction with glass and carbon filled TFE seal rings, screwed connections with integral check readout valves and caps and calibrated nameplate and memory stop and drain connection. Elements pressure rated for 300 psig and 250 degree f.

2.10 VENTURI-TYPE FLOW ELEMENTS

A. Type: Differential-pressure venturi type, designed for installation in piping.

B. Construction: Bronze or cadmium-plated steel with brass fittings and attached tag with flow conversion data. Ends shall be threaded for 2 inches and smaller elements and flanged or welded for 2-1/2 inches and larger elements.

2.11 PITOT TUBE-TYPE FLOW ELEMENTS

A. Type: Differential-pressure pitot tube-type design with probe for insertion into piping.

B. Construction: Stainless steel probe of length to span inside of pipe, with brass fittings and attached tag with flow conversion data. Elements shall be pressure rated for 150 psig and 250 degree F (120 Degree C).

2.12 METERS

A. Portable Meters: Differential-pressure gage and two 12-foot hoses in carrying case with handle.

B. Scale: In inches of water unless otherwise indicated.

C. Accuracy: Plus or minus 2 percent between 20 to 80 percent of range.

D. Each meter shall be complete with operating instructions.

2.13 TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: conform to the following for fluids and temperature range:

1. Air, Water, Oil, and Gas, 20 to 200 degree F: Neoprene.

C. Test Kit: Provide test kit consisting of 1 pressure gage, gage adapter with probe, 2 bimetal dial thermometers, and carrying case.

D. Ranges of pressure gage and thermometers shall be approximately 2 times systems operating conditions.

PART 3 - EXECUTION

3.01 THERMOMETERS INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install in the following locations and elsewhere as indicated:

1. At inlet and outlet of each hydronic zone.
2. At inlet and outlet of each hydronic boiler and chiller.
3. At inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. At inlet and outlet of each hydronic heat exchanger.
5. At inlet and outlet of each hydronic heat recovery unit.
6. At inlet and outlet of each thermal storage tank.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.02 INSTALLATION OF PRESSURE GAGES

A. Install pressure gages in piping tee with pressure gage valve, located on pipe at most readable position.

B. Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each pump.
2. At discharge of each pressure-reducing valve.
3. At building water service entrance.
4. At chilled water and condenser water inlets and outlets of chillers.

C. Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.03 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.04 INSTALLATION OF FLOW-MEASURING ELEMENTS AND METERS

A. Locations: Install flow measuring elements in the following locations and elsewhere as indicated.

1. At discharge of each pump.
2. At inlet of each hydronic coil in built-up central systems.

B. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as described by the manufacturer's installation instructions.

C. Install wafer orifice-type element between 2 Class 125 pipe flanges, ANSI B16.1 (cast iron) or ANSI B16.24 (bronze).

D. Install connections for attachments to portable flow meters in a readily accessible location.

3.05 INSTALLATION OF CALIBRATED BALANCE VALVES

A. Install calibrated balance valves in the following locations and elsewhere as indicated.

1. At each fan coil unit.
2. At each unitary water source heat pump.
3. At each 3-way valve.

3.06 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.07 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 23. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gages piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 23 0519

SECTION 23 0900

COMMISSIONING OF SMOKE-CONTROL SYSTEMS

PART 1 - GENERAL

1.01 TESTING PROCEDURES

A. Smoke control systems are designed to limit smoke migration at the boundaries of smoke control areas of Stair #1 and Stair #2 using pressure differences. Stairwell pressurization system is used to limit smoke movement from the floor area into the stairwell and thus provide a tenable environment during egress. Testing appropriate to the objective of the system consists of measuring the pressure difference between the smoke zone and the adjacent zones. The testing procedures provided in this section are based on the measurement of pressure differences and door-opening forces under the design conditions agreed on with the authority having jurisdiction based on the calculation submitted to Divisions of State Architect during the design review process. Detailed engineering design information is contained in ASHRAE/SFPE Principles of Smoke Management and the NFPA publication Smoke Movement and Control.

B. Preliminary Building Inspections

1. Prior to testing, the party responsible for testing shall verify completeness of building construction. [NFPA 92-12: 8.2.1] The following architectural features, where applicable, shall be inspected:

   a. Smoke barriers, including joints therein
   b. Shaft integrity
   c. Fire stopping
   d. Doors/closers
   e. Glazing, including that enclosing a large-volume space
   f. Partitions and ceilings [NFPA 92-12: 8.2.2]

C. The verification suggested in this section should be in the form of an inspection report or punch list for incomplete installations. The inspection should include each wall or floor penetration to verify that a fire stop, or a rated fire penetration sealing material, has been installed. This verification should include a review of the specified materials, the approved product data submittals, and installation plans or sketches.

1.02 OPERATIONAL TESTING

A. The project specifications and system description clearly spells out the objectives of operational testing. Prior to performing any tests, an inspection of the completed system should be made and documented in an inspection report verifying the completeness of Smoke-Control for Individual Systems installation. The inspection report can also include a punch list of incomplete items. The inspection is also an opportunity to revise installation plans to include any field changes, thus allowing the installation plans to be updated to as-built status.

B. The intent of component system testing is to establish that the final installation complies with the specified design, is functioning properly, and is ready for acceptance

testing. Operational testing of system components should be completed during construction. These operational tests normally are performed by various trades before interconnection is made to integrate the overall smoke control system. It should be documented in writing that each individual system component’s installation is complete and the component is functional. Each component test, including items such as speed, volume, sensitivity calibration, voltage, and amperage, should be individually documented. [NFPA 92-12: A.8.3]

C. An operational test of each smoke control system component and subsystem shall be performed prior to the acceptance test. [NFPA 92-12: 8.3.1] Operational tests shall be performed prior to interconnection of individual components and subsystems to the smoke control system. [NFPA 92-12: 8.3.2] Smoke control system operational testing shall include all subsystems to the extent that they affect the operation of the smoke control system. [NFPA 92-12: 8.3.3]

D. Systems that could affect or be affected by the operation of the smoke control system include the following:

1. Fire alarm system (see NFPA 72®)
2. Energy management system
3. Building management system
4. Heating, ventilating, and air-conditioning (HVAC) equipment
5. Electrical equipment
6. Temperature control system
7. Power sources
8. Standby power
9. Automatic suppression systems
10. Automatic operating doors and closures
11. Other smoke control systems
12. Emergency elevator operation
13. Dampers
14. Fire fighters’ control station (FFCS) [NFPA 92-12: A.8.3.3]

E. All documentation from component system testing relative to the smoke control system shall be included in the final testing documentation. [NFPA 92-12: 8.3.5]

1.03 ACCEPTANCE TESTING

A. Acceptance testing shall demonstrate that the final integrated system installation complies with the specific design and is functioning properly. [NFPA 92-12: 8.4.1]

B. Where appropriate to the design, all parameters shall be measured during acceptance testing. [NFPA 92-12: 8.4.2]

C. The locations for measurement of the parameters identified in NFPA 92-12 and this document shall be in accordance with nationally recognized methods. [NFPA 92-12: 8.4.3]

D. The acceptance testing shall include the procedures described in 8.4.4.1 through 8.4.4.4. [NFPA 92-12: 8.4.4]

E. Prior to beginning acceptance testing, all building equipment shall be placed in the normal operating mode, including equipment that is not used to implement smoke control. [NFPA 92-12: 8.4.4.1]

F. Program for Individual Systems If standby power has been provided for the operation of the smoke control system, the acceptance testing shall be conducted while on both normal and standby power. [NFPA 92-12: 8.4.4.2]

G. The acceptance testing shall include demonstrating that the correct outputs are produced for a given input for each control sequence specified. [NFPA 92-12: 8.4.4.3]

H. The complete smoke control sequence shall be demonstrated for the following:

1. Normal mode
2. Automatic smoke control mode for first alarm
3. Transfer to standby power if provided.
4. Return to normal [NFPA 92-12: 8.4.4.4]

1.04 SUMMARY

A. Commissioning of smoke-control systems must be based on the BOD and the performance of the system described therein. NFPA 92, Standard for Smoke-Control Systems, contains prescriptive measures for the testing of these systems. The procedures outlined herein should be followed to establish the BOD and the submission of plans, calculations, and project closeouts.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 0900

SECTION 23 0923

DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Rio Hondo College has standardized on the Alerton building management system & control suite. No exceptions. This Building Management System (BMS) integrates building management controls and energy management, and shall be an Alerton system consistent and seamlessly integrated with the existing campus building control system.

B. The control contractor shall have been an authorized Alerton dealer in Southern California for at least (10) years and have a minimum of (15) factory certified technicians on staff prior to the bid. The contractor must furnish all labor, materials, equipment, and service necessary for a complete and operating system, utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.

C. The BMS shall be capable of total integration of the facility infrastructure systems with user access by a standard Web Browser over the Internet. This shall include HVAC control, electrical, gas and water metering, energy management, alarm monitoring, security and personnel access control, fire-life safety monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated on the drawings or elsewhere in this specification.

D. All central plant & air handler controllers shall be the Alerton BACtalk VLX, and the field level controllers shall be the Alerton BACtalk VLC. Other controller brands that operate with BACnet protocol will not be accepted.

E. Provide the detail design of the system, furnish and install hardware, start-up and commissioning of the system and then warrant the completed system including equipment, appurtenances, and existing campus system modifications.

F. Provide a Building Management System (BMS) incorporating Direct Digital Control (DDC) Energy Management, monitoring and control of HVAC equipment and room control. The BMS shall be fully integrated to provide the end users with full control, monitoring and management functions based on a common computer operating system and operating procedures.

G. The building HVAC control system will be comprised of microprocessor based plant controllers and intelligent room controllers interfacing directly with sensors, actuators, HVAC equipment, chillers, boilers, room climate control, lighting systems, and electrical systems.

H. Furnish a totally native BACnet-based system, based on a distributed control system in accordance with this specification. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2001, BACnet.

In other words, all controllers, including unitary controllers, shall be native BACnet devices. The control system shall be Alerton BACtalk to match existing campus standards.

I. The BMS shall be listed by the Underwriters Laboratories Inc. (ULI) for use in energy management, (PAZX), critical process (QVAX), security (APOU), and the primary control and monitoring device for smoke control (UUKL) and fire alarm systems (UOJZ). In addition to the above listings, the BMS shall have the ability to integrate all open communications protocol standards including BACnet, LonMark, ODBC, OPC, Advance DDE and Modbus. The BMS shall have the ability to simultaneously allow open integration and control of stand-alone systems, HVAC, fire, security, lighting, asset tracking and monitoring CCTV and digital video systems.

J. Complete temperature control system to be DDC with electronic sensors and electric/electronic actuation of valves and dampers.

K. The system shall include all interconnecting wiring and conduit as required for an operational system under this section of the specification. Wiring and conduit shall be installed as per local codes or Division 26 whichever is more stringent, and a letter indicating method of code compliance which shall be furnished with first shop drawing submittal.
   1. Line voltage wiring shall utilize methods and materials complying with the requirements of the Electrical Specifications, local building code, and NEC.
   2. Low voltage wiring shall use methods and materials complying with the requirements of the Electrical Specifications, local building code and NEC.

L. Where interface between a device such as a variable frequency drive and the building management system is required and the manufacturer’s interface card does not provide the required points or information then the required points shall be hard wired from the device to the required destination. The required points shall be landed, and all control logic for those points shall be implemented at no additional cost to the campus. The intent shown on the construction document for those required points shall be implemented to the satisfaction of the campus.

1.02 QUALITY ASSURANCE DURING CONSTRUCTION

A. The acceptable manufacturer is:
   1. Alerton.
   2. No known equal.

B. The acceptable installer is:
   1. Climatec.
   2. No known equal.

C. The Building Control System shall be integrated to the existing campus Alerton Building Management System. The controls contractor responsible for the controls interface with the Rio Hondo College Alerton Building Management System shall be Climatec or an approved equal. Request for approval must be submitted at least 14 days before bid.

D. Prior to receiving approval to proceed on this project the contractor must provide and demonstrate the following:
   1. A copy of Southern California Alerton dealership license.
   2. Ten (10) customer references in Los Angeles County with the installed Alerton BACtalk systems as specified for this project.
   3. Five (5) projects, larger than this project, completed in the last 2 years, in Southern California with the Alerton BACtalk system installed as specified for this project.
   4. Reference Information must include the following:
      a. Customer name
      b. Address
      c. Contact name
      d. Contact phone number
      e. System description
      f. Statement of BACnet compliance

E. The authorized Alerton BACtalk Installer shall coordinate all portions of the project and perform final integration.

F. Contractor performing work as part of this specification shall be fully responsible for all building automation system warranties in all buildings whether existing or in construction at the Rio Hondo College.

G. The control contractor must perform all engineering, programming, and project management in house. Subcontracting or brokering of these responsibilities is not allowed of the control contractor.

H. The Installation Contractor shall be responsible for the complete installation, including the initial data input, system debugging, and initial calibration of system components.

I. A full-time Project Manager with a minimum of ten (10) years experience with facilities of this size project and complexity shall be assigned to manage both the engineering/design and system installation/start-up phases of the projects. Close coordination and approval from and with the Design Professional is required.

J. Control system shall be engineered, programmed, and supported completely by representative’s local office that must be within 20 miles of project site. The control contractor shall be independent and not part of a Mechanical Contractor’s control division.

K. The Building Control System Contractor shall submit a list of projects with contact names as part of his submittal package. The contractor shall possess valid California State Class C-10 and C-20 license.

L. Rio Hondo College reserves the right to immediately disqualify contractors and products that do not meet the specific requirements as outlined in this specification.

1.03 SUBMITTALS

A. Submit complete coordination system documentation including, but not limited to:
   1. Equipment location and conduit routing drawings.
   2. Point-to-point wiring diagrams.
   3. Descriptive literature and specification sheets for hardware and equipment.
   4. Operating and maintenance instructions on hardware and equipment.
   5. I/O (input/output device) point assignments.
   6. Complete schedule and legend listing sensors, readers, etc., indicating its location, make and model number, I/O assignment, etc. Room numbers shall be actual, final building room numbers.
   7. Database and software modification documentation indicating sequences of operation, listing of control program additions, flow charts of control program additions, and proposed floor maps with symbols to be programmed into the existing campus central EMS database.
   8. Procedures and documents to be used for training, check-out, and commissioning.

1.04 FUNCTION

A. Design and install an integrated building control system including necessary hardware and software to perform the functions intended.

B. The system shall be fully integrated to the existing campus Alerton building controllers and the existing hardware and software shall be modified to include the extended system.

C. The system shall provide the following functions:
   1. Monitor control and alarm points for alarm and status.
   2. Log selected events to the host system database.
   3. Upload and download data to the central server database server.
   4. Display alarms on the host system terminal including a location plan.
   5. The building management control decisions shall be made locally by the building controller automatically without the need for any operator intervention. Whenever an alarm or other exceptional situation occurs, the controller shall automatically transmit event data to the central campus BMS server via a dedicated connection while simultaneously alerting any remote alarm monitoring station, executing preprogrammed output commands as established by the system design submittals.
   6. The BMS shall perform data acquisition of facility point conditions and shall be capable of uploading transactions and/or events to the existing campus central database system and include the date, time, location, and nature of the event.
   7. The BMS shall utilize distributed control architecture to ensure minimum down time in the event of a single or multiple component failure. The BMS shall be capable of identifying the failed component(s) and bring it to the attention of the existing campus central server operator.
   8. The BMS shall possess a modular architecture that permits 25% expansion of the system through the addition of expansion boards and memory to a building terminal controller and adding more building control panels, sensors, and readers.

1.05 WARRANTY

A. All components, system software, and parts supplied by the building control system contractor shall be guaranteed against defects in materials and workmanship for three (1) years from acceptance date.

B. Labor to repair, reprogram, or replace components shall be furnished by the building control system contractor at no charge during the warranty period.

All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the Owners request for warranty service within 24 hours during normal business hours.

1.06 LOCAL AREA NETWORK

A. The Local Area Network (LAN) shall be a 100 Megabits/sec (Minimum) Ethernet network supporting BACnet for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:
1. Ethernet; IEEE standard 802.3
2. Cable; 100 Base-T, UTP-8 wire, Category 5
3. Minimum throughput; 100 Mbps.

1.07 REMOTE ACCESS

A. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

PART 2 - PRODUCTS

2.01 BUILDING MANAGEMENT SYSTEM AND COMPONENTS DESCRIPTION

A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices and other devices as specified herein.
1. Building Management System to be provided shall perform the following general functions:
   a. Building management and control
   b. Monitoring and control of controllers, remote devices and programmable logic controllers including sensors, actuators, environmental delivery systems (chillers, boilers, room climate control, lighting systems, electrical systems etc.)
   c. Operator interface to allow general supervision of room controls
   d. Data collection and historization
   e. Alarm management
   f. Trending

g. Report generation
h. Network integration

2. Data exchange and integration with a diverse range of other computing and facilities systems using industry standard techniques.
3. System shall employ all standard features and functions as described in Section 1 to monitor and control building equipment. At a minimum, the following data shall be accessible:
   a. Space temperature
   b. Space temperature set-point
   c. Occupancy status
   d. Operating mode
   e. Window status
   f. Valve positions
   g. Air volume flow
   h. Percent terminal load
   i. Time schedules
   j. Zero energy bands
   k. Room name
   l. Terminal type e.g. fan coil
4. In the event of a power failure or disconnection from the network, the controllers shall continue to be fully operational with full time program capability.

B. Web Browser Clients:
1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Mozilla FireFox™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BMS, shall not be acceptable.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:
   a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
   b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
   c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
   d. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
   e. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

(1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
  (a) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
  (b) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
(2) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
(3) View logs and charts
(4) View and acknowledge alarms
(5) Setup and execute SQL queries on log and archive information

f. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

g. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

C. On-line Help:
1. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

D. Security:
1. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.
2. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data.
3. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators’ access for viewing and/or changing each system application, full screen editor, and object.
4. User log-on and log-off attempts shall be recorded.
5. All system security data shall be stored in an encrypted format.
6. System shall protect itself from unauthorized use by automatically logging off five minutes following the last keystroke or mouse activity.

E. System Diagnostics:
1. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
2. Provide fully licensed software with no recurring fees for programming of controllers.

F. Alarm Console:
   1. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
   2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.02 SERVER FUNCTIONS AND HARDWARE

A. Alerton campus central server is located in the maintenance and operations office. The server supports all Alerton Control Modules (ACM), a Network Area Controller (NAC) connected to the customer’s network whether local or remote.

B. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.

C. The server shall provide the following functions, at a minimum:
   1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
   2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.

D. The server shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).

E. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.

F. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.

G. The server shall provide demand limiting that operates across all Network Area Controllers. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.

H. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.

I. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.

J. The server shall provide central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:
   1. Routing of alarms to display, printer, email and pagers
   2. View and acknowledge alarms
   3. Query alarm logs based on user-defined parameters

K. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
   1. Viewing and printing log data
   2. Exporting log data to other software applications
   3. Query log data based on user-defined parameters

L. Connection to the BMS network shall be via an Ethernet network interface card, 100 Mbps.

M. Graphics:
   1. Provide custom dynamic graphics for systems and controlled devices installed in this project.
   2. Provide standardized intelligent dynamic graphics for application specific controllers that will automatically modify itself based on system components installed.

2.03 NETWORK AREA CONTROLLER (NAC)

A. The Alerton Control Module, ACM 1 GB of DDR3 SDRAM and a Quad Core 996 GHz processor shall be the only acceptable Network Area Controller (NAC).
General Requirements:
   1. BACnet Conformance
      a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
      b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
   2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.
   3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.
   4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.
   5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.

6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.
7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator’s workstation or field computer.
9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.
10. Controller IP configuration can be done via a direct USB connect with an operator’s workstation or field computer.
11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.
12. Global control algorithms and automated control functions shall execute using a 64-bit processor.
13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.
14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
    a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.
    a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.
16. All ports shall be capable of having protocol(s) assigned to utilize the port’s physical connection.
17. The controller shall have at a minimum four (4) onboard inputs, two (2) universal inputs and two (2) binary inputs.
18. Schedules
    a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.
    b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.
19. Logging Capabilities
    a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.
    b. Logs may be viewed both on-site or off-site using WAN or remote communication.
    c. Building controller shall periodically upload trended data to networked operator’s workstation for long-term archiving if desired.
    d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

20. Alarm Generation
    a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
    b. Each alarm may be dialed out as noted elsewhere.
    c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site using remote communications.
    d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.
21. Demand Limiting
    a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.
    b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.

B. BACnet MS/TP
1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps
    a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.
    b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. BACnet IP
1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).
2. Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).
3. Each controller shall support at a minimum 128 BBMD entries.
4. BBMD management architecture shall support 3,000 subnets at a minimum.
5. Shall support BACnet Network Address Translation.
6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

D. Expansion Ports
1. Controller shall support two (2) expansion ports.
    a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.
2. Expansion cards that mate to the expansion ports shall include:
    a. Dual port EIA-485 card.

E. Power Supply
1. Input for power shall accept between 17 and 30VAC, 47 and 63Hz.
2. Rechargeable battery for shutdown of controller including storage of all data in flash memory.
3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

F. Controller shall be in compliance with the following:
   1. UL 916 for open energy management
   2. FCC Class B
   3. ROHS
   4. IEC 60703
   5. C-Tick Listed

G. Controller shall operate in the following environmental conditions:
   1. -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery.
   2. 0 to 95% relative humidity (RH), non-condensing.

H. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

I. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

J. Event Alarm & Notification Actions:
   1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
   3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
      a. To alarm
      b. Return to normal
      c. To fault
   4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
   5. Provide timed (schedule) routing of alarms by class, object, group, or node.
   6. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
   7. Control equipment and network failures shall be treated as alarms and annunciated.
   8. Alarms shall be annunciated in any of the following manners as defined by the user:
      a. Screen message text
      b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
         1) Day of week
         2) Time of day
         3) Recipient
      c. Pagers via paging services that initiate a page on receipt of email message
      d. Graphic with flashing alarm object(s)
      e. Printed message, routed directly to a dedicated alarm printer

9. The following shall be recorded by the NAC for each alarm (at a minimum):
   a. Time and date
   b. Location (building, floor, zone, office number, etc.)
   c. Equipment (air handler #, access way, etc.)
   d. Acknowledge time, date, and user who issued acknowledgement.
   e. Number of occurrences since last acknowledgement.
10. Alarm actions may be initiated by user defined programmable objects created for that purpose.
11. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
12. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
13. Provide a “query” feature to allow review of specific alarms by user defined parameters.
14. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
15. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

K. Data Collection & Storage:
1. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
   a. Designating the log as interval or deviation.
   b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
   c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
   d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
   e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
3. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
4. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
5. All log data shall be available to the user in the following data formats:
   a. HTML
   b. XML
   c. Plain Text
   d. Comma or tab separated values
6. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

7. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
   a. Archive on time of day
   b. Archive on user-defined number of data stores in the log (buffer size)
   c. Archive when log has reached its user-defined capacity of data stores
   d. Provide ability to clear logs once archived

L. Audit Log:
1. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
   a. Time and date
   b. User ID
   c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

M. Database Backup & Storage:
1. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
2. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
3. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

N. Graphical User Interface Software
1. Operating System:
   a. The GUI shall run on Microsoft Windows XP Professional.
2. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
3. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
   a. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
   b. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
   c. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.

d. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
   1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
   2) Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
e. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
f. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

4. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
   a. Create, delete or modify control strategies.
   b. Add/delete objects to the system.
   c. Tune control loops through the adjustment of control loop parameters.
   d. Enable or disable control strategies.
   e. Generate hard copy records or control strategies on a printer.
   f. Select points to be alarmed and define the alarm state.
   g. Select points to be trended over a period of time and initiate the recording of values automatically.

2.04 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods:

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object’s property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. All programming shall be graphical and utilize a non proprietary tool like Microsoft Visio. Text based programming is not acceptable.
4. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
5. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
6. The system shall support object duplication within a customer’s database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

D. Scheduling:

1. Provide the capability to schedule each object or group of objects in the controller system. Controllers shall have a minimum of 20 schedules. Each schedule shall consist of the following:
    a. Daily schedule: Provide daily schedules that are the basic building blocks for any of the following time schedules. Using daily schedules, user shall enter the switching times with the desired set points and switching conditions for the data-points. When preparing a daily schedule and assigning the name, there is initially no specific relationship to a particular day in the week. The modular structure of the time schedule shall make it possible for the user to establish various different daily schedules, keep them in a library, and include them in the weekly schedule. User shall be free to extend the list of daily schedules to meet his/her special requirements. The repeated use of the same daily schedule shall also be possible (for example, the same daily schedule can apply from Monday to Friday in the weekly schedule). Changes in a daily schedule shall be immediately effective in the weekly and annual schedules, as well as in the special day list.

b. Weekly schedule: Provide a separate weekly schedule that shall be generated for each time schedule. Weekly schedule defines which daily schedule is to be used for which weekday. A daily schedule is assigned to each day of the week (Monday to Sunday). It shall also be possible to assign the same daily schedule to several weekdays. Weekly schedule, as defined, shall automatically be copied for each week in the annual schedule. If a change is made to a weekday in a weekly schedule, this change shall affect the weekday in every week of the year. If a daily schedule is entered directly in the annual schedule, this daily schedule shall have priority over the daily schedule from the weekly schedule. Definition of a weekly schedule forms the basis of the annual schedule.
c. Annual schedule: Provide an annual schedule that is structured like a calendar and consists of successive weekly schedules. It provides an overview of which daily schedules are valid on which calendar days. If the daily schedule in a weekly schedule does not apply on a particular calendar date, another daily schedule can be entered for it directly in the annual schedule. Annual schedule starts on the current day. Each day, the time frame shifts one day. Days added at the end shall automatically be assigned the daily schedule from the weekly schedule. Entries in the annual schedule shall therefore be made only if a daily schedule differing from the one selected is to be used. An undefined daily schedule to be inserted in the annual schedule can be defined in the daily schedule.
d. Holiday schedule: Provide one holiday day list that shall exist per time schedule. List shall make a number of holidays and special days available to which a daily schedule can be assigned. This daily schedule will then apply to this holiday or special day every year. The date of floating holidays shall be calculated automatically by the controller. If no daily schedule is entered on certain holidays, the special day list is not taken into account on this day. Provide capability for 24 holidays and special days.

E. Digital alarms: Each digital object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

F. Analog alarms: Provide analog objects with two maximum limits (limit max 1 and limit max 2), and two minimum limits (limit min 1 and limit min 2).

G. Totalizer alarms: Each totalizer object shall be set to alarm based on a pulse input signal interval that, if exceeded, triggers an alarm signal. Alarm signal text shall be permanently programmed and needs no input from the user.

H. Alarms shall be selectable as critical or non-critical. Critical alarms shall be transmitted as high priority.

I. System alarms: Operating errors that occurs in a control unit or during communication with other controllers shall be recognized and displayed by the computer module. These alarm signals can relate, for example, to a defective module, the need to change the buffer battery (data protection), or the presence of one digital output module too many (maximum 10). These alarm signal texts are preprogrammed. They are always critical alarms.

J. Demand limiting:
   1. Demand-limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter or from a watt transducer or current transformer attached to the building feeder lines.
   2. Demand-limiting program shall predict the probable power demand such that action can be taken to prevent exceeding the demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates the demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
   3. Demand reduction shall be accomplished by the following means:
      a. Reset air-handling unit supply temperature set point up by 1 degree C (2 degrees F).
      b. Reset space temperature set points up by 1 degree C (2 degrees F).
      c. De-energize equipment based upon priority.
   4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which the local power company computes demand charges.
   5. Provide demand-limiting prediction and control for any individual meter monitored by the system or for the total of any combination of meters.
   6. Provide the means for an operator to make the following changes on-line:
      a. Addition and deletion of loads controlled.
      b. Changes in demand intervals.
      c. Changes in demand limit for meter(s).
      d. Maximum shutoff time for equipment.
      e. Minimum shutoff time for equipment.
      f. Select rotational or sequential shedding and restoring.
      g. Shed and restore priority.
   7. Provide the following information and reports, to be available on an hourly, daily, and monthly basis:
      a. Total electric consumption
      b. Peak demand
      c. Date and time of peak demand
      d. Daily peak demand

K. Sequencing: Provide application software based upon the sequences of operation specified to properly sequence chillers, boilers, and pumps.

L. EPID control: An EPID (enhanced proportional-integral-derivative) algorithm with additional features shall be supplied. Algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. Enhanced features shall include a built-in start-up ramp, direct-reverse action selection, integral recalculation to prevent windup below minimum and above maximum, and an auxiliary input for limit applications and integral reset. Controlled variable, set point, and PID gains shall be user-selectable.

M. Staggered start: This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment or groups of equipment is started, along with the time delay between starts, shall be user-selectable.

N. Energy calculations:
   1. Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., GPM) to be accumulated and converted to energy usage data.
   2. Provide an algorithm that calculates a sliding window average (e.g., rolling average). Algorithm shall be flexible to allow window intervals to be user-specified (e.g., 15 minutes, 30 minutes, and 60 minutes).
   3. Provide an algorithm that calculates a fixed window average. A digital input signal will define the start of the window period (e.g., signal from utility meter) to synchronize the fixed window average with that used by the utility.

O. Anti-short cycling: Digital output objects shall be protected from short cycling. This feature shall allow minimum on time and off time to be selected.

P. On and off control with differential: Provide an algorithm that allows a digital output to be cycled based on a controlled variable and set point. Algorithm shall be direct acting or reverse acting and incorporate an adjustable differential.

Q. Duty cycle: Provide software to switch HVAC systems on and off at variable intervals to save energy while maintaining room conditions. Program shall have adjustable internal parameters for room comfort range, maximum off times, minimum off times, and motor cycle times.

R. Economizer: Provide software that determines the most economical system operation for full and partial air conditioning systems. For a full air conditioning plant, it calculates the control signal for energy recovery on the basis of actual outdoor air enthalpy, return air enthalpy, and demand. In partial air conditioning systems, this control icon shall be used for heat recovery with temperature comparison. Economizer program shall make decisions based on the following information: Is the system a full or partial air conditioning system. A full system has temperature and humidity control. A partial system has temperature control only. Is there mixed air damper operation or heat and humidity recovery using a thermal wheel? Which has the higher energy cost: heating or cooling?

S. Night purge: Provide a program that outputs a 'on and off' value to start and stop ventilation and air conditioning systems to precondition rooms when cold outdoor air is available during non-working hours (usually, nighttime). To switch on the air conditioning as late as possible, this function shall permit room temperature to drop below room temperature set point during night cooling. Night purge shall achieve this action by resetting the room temperature set point downward. Minimum outdoor air temperature shall be limited to prevent damage from excessively cold outdoor air.

T. Optimum start and stop: Provide a software program that calculates optimized values for starting and stopping the heating plant. Optimized start-stop function shall consider the residual heat in a building to avoid unnecessary heating operation. Required room conditions are met at all times. Optimum start and stop program calculates required flow temperature with an integrated heating curve.
Two techniques shall be available: optimization without room sensor or optimization with room sensor. Optimization without room sensor uses outdoor air temperature to determine optimum start (the preheat point). Optimization with room sensor uses room control and needs a time constant (time program) and dead time to calculate the preheat point.

U. Zero energy band: Provide a software program that determines set points to maintain a predetermined comfort band divided into heating, cooling, and zero energy bands. ZEB subdivides a predetermined comfort band into: Heating band zero energy band cooling band. Zero energy band represents a temperature range in which the room temperature may vary without a need for heating or cooling.

V. Run-time totalization: Provide software to totalize run times for all digital input objects. A high run-time alarm shall be assigned, if required, by the operator.
1. Data references like text descriptors, historical data, alarm buffer, engineering units, engineering characteristics etc. must be resident inside the building controller.
2. Provide at minimum 1000 BACnet ® Objects, of which a minimum 300 physical I/Os must be possible.

2.05 EXPANDABLE AIR HANDLING UNIT CONTROLLERS

A. General:
1. Alerton VLX Platinum, native BACnet controller shall be used for these applications.
2. Expandable application controller shall be capable of providing control strategies for the system based on information from any or all connected inputs. The program that implements these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site via simple download are not acceptable. Changing global strategies via firmware changes is also unacceptable. Program execution of controller shall be a minimum of once per second.
3. Programming shall be object-oriented using control program blocks. Controller shall support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value shall support standard BACnet priority arrays. Programming tool shall be provided with system and shall be the same tool that is used to program the Building Controller. All flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary.
4. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator’s terminal or field computer.
5. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall-retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. Unused battery life shall be 10 years.
6. The onboard, battery-backed real time clock must support schedule operations and trend logs.
7. Global control algorithms and automated control functions should execute via 32-bit processor.
8. Controller shall include both on-board 10BASE-T/100BASE-TX Ethernet BACnet communication over twisted pair cable (UTP) and shall include BACnet IP communication. In addition, controller shall include BACnet PTP connection port.

9. The base unit of the controller shall host up to 8 expansion modules with various I/O combinations. These inputs and outputs shall include universal 12-bit inputs, binary triac outputs, and 8-bit switch selectable analog outputs (0-10V or 0-20 mA). Inputs shall support 3K and 10K thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.
10. All outputs must have onboard Hand-Off-Auto switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
11. The position of each and every HOA switch shall be available system wide as a BACnet object. Expandable Central Plant Controller shall provide up to 176 discreet inputs/outputs per base unit.

B. BACnet Conformance:
1. Central Plant/AHU Controller shall as a minimum support Point-to-Point (PTP), MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Building controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Clock Functional Group
   b. Files Functional Group
   c. Reinitialize Functional Group
   d. Device Communications Functional Group
   e. Event Initiation Functional Group
2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include as a minimum: Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program and Schedule object types. All necessary tools shall be supplied for working with proprietary information.
4. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

C. Schedules: Each Central Plant/AHU controller shall support a minimum of 50 BACnet Schedule Objects.

D. Logging Capabilities:
1. Each controller shall support a minimum of 200 trend logs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Controller shall periodically upload trended data to system server for long term archiving if desired.
3. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs

E. Alarm Generation:
1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site via remote communications
3. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

2.06 TERMINAL UNIT APPLICATION CONTROLLERS (HEAT PUMPS, AC UNITS, FAN COILS)

A. Provide one Alerton Visual Logic Controller (VLC) that is a native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance:
1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Files Functional Group
   b. Reinitialize Functional Group
   c. Device Communications Functional Group
2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include as a minimum–Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, 4–20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for the Microset 4 intelligent room sensor. Display on the room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.07 TERMINAL BOX CONTROLLERS—SINGLE DUCT

A. Provide one native BACnet application controller for each terminal box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. BACnet Conformance
   1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
      a. Files Functional Group
      b. Reinitialize Functional Group
      c. Device Communications Functional Group
   2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
   3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types.
      All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure independent control algorithms and all flow readings shall be in CFM (LPS if metric).

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using the same programming tool as Building Controller and as described in operator workstation section. All programming tools shall be provided as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.9.B.) Display on room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence for specific display requirements for intelligent room sensor.

F. On board flow sensor shall be microprocessor driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in EEPROM. Calibration data shall be field adjustable to compensate for variations in terminal box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator workstation, portable computers and special hand-held field tools shall not be needed for field calibration.

G. Provide duct temperature sensor at discharge of each terminal box that is connected to controller for reporting back to operator workstation.

2.08 INPUT AND OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through general purpose, custom application, unitary controllers or distributed I/O devices.

B. Input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to controller. Input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to controller. Inputs and outputs shall be arranged on interchangeable modules or circuit boards to allow the replacement of a damaged module or board without replacing the entire controller.

C. Digital inputs shall allow the monitoring of on and off signals from remote devices. Digital inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices, and shall be protected against the effects of contact bounce and noise. Digital inputs shall sense dry contact closure without external power other than that provided by the controller being applied.

D. Totalizer input points: This type of point shall conform to all requirements of digital input points, and also accept up to 15 pulses per second for pulse accumulation.

E. Analog inputs for GPCs shall be minimum 12-bit resolution and allow the monitoring of low-voltage (0 to 10 VDC), current (0 to 20 mA), negative temperature coefficient (NTC), and resistance to detector (RTD). Analog inputs shall be compatible with and field-configurable to commonly available sensing devices. To prevent thermal loading, RTDs and thermistors shall be scanned rather than have continuous power applied.

F. Inputs shall be electrically isolated from their associated field points.

G. Digital outputs shall provide for on and off operation, or a pulsed low-voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.

H. Analog outputs shall be minimum 8-bit resolution and provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on general purpose or custom application controllers shall have status lights and a two-position Auto and Manual switch and manually adjustable potentiometer with feedback for manual operation. Analog outputs shall not exhibit a drift of greater than 0.4 percent of range per year.

I. Tri-State outputs: Provide tri-state outputs (two coordinated digital outputs) for control of three-point floating-type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation). Control algorithms shall run the zone actuator to one end of its stroke every 24 hours for verification of operator tracking.

J. System point capacity: System size shall be expandable to at least two times the number of hardware and software input and output points required for this project or 20,000 points, whichever is greater. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. Operator interfaces installed for this project shall not require any hardware additions or software revisions to expand the system.

K. Spare I/O Points: At each controller location, provide spare points equal to 15 percent of total I/O points at that location or 2 AI, 2 AO, 2 DO and 2 DI, whichever is greater.

2.09 POWER SUPPIES AND LINE FILTERING

A. Control transformers shall be UL and CSA Listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80 percent of rated capacity

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1. 0 percent line and load combined, with 100-microsecond response time for 50 percent load changes.
   Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150 percent current overload for at least three seconds without trip-out or failure.
   a. Unit shall operate between 32 degrees F and +120 degrees F. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
   b. Line voltage units shall be UL Recognized and CSA approved.

B. Power line filtering:
1. Provide transient voltage and surge suppression for all workstations and controllers, either internally or as an external component. Surge protection shall have the following at a minimum:
   a. Dielectric strength of 1,000 volts minimum
   b. Response time of 10 nanoseconds or less
   c. Transverse mode noise attenuation of 65 dB or greater
   d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz

2.10 FIELD CONTROL DEVICES

A. Temperature Sensors:
1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application.
2. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor.
3. Duct sensors to be installed such that the sensing element is in the main air stream.
4. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors.
5. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

B. Intelligent Room Sensor with LCD Readout:
1. The intelligent room sensor shall be the Microset 4 by Alerton.
2. Sensor shall contain a backlit touch-screen LCD digital display along with temperature & humidity sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower set-point, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
3. The Intelligent Room Sensor shall simultaneously display room set point, room temperature, outside temperature, humidity, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application.
   The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.

4. Override time may be set and viewed in half-hour increments. Override time count-down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
5. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.
6. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to terminal controller, terminal box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Wall Sensor:
1. All thermostats shall be the Microtouch II by Alerton, and shall be a communicating, intelligent thermostat with a microprocessor.
2. Standard wall sensor shall use solid-state sensor identical to intelligent room sensor and shall be packaged in aesthetically pleasing enclosure.
3. Sensor shall provide override function, warmer/cooler lever for set point adjustment and port for plug-in of Field Service Tool for field adjustments. Override time shall be stored in controller and be adjustable on a zone-by-zone basis.
4. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller.
5. All programmable variables shall be available to Field Service Tool through wall sensor port.

D. Relays:
1. Control relays shall be UL Listed plug-in type. Contact rating, configuration, and coil voltage suitable for application. Honeywell R4228/8228.
2. Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable *200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

E. Voltage Transformers:
1. AC voltage transformers shall be UL and CSA recognized, 600 VAC rated, complete with built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of +40 to +130 degrees F and shall provide *0.5 percent accuracy at 24 VAC and a 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.
4. Transmitters
   a. Transmitter shall operate on 24 VAC. Transmitter shall not require an isolated power source.
   b. Operating temperature range for the transmitter shall be -20° F to 120° F. Protect transmitter from weather and water.
   c. Communication with host controls using one of the following interface options:
      1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire)
      2) RS-485: Field selectable BACnet-MS/TP, ModBus-RTU
5. Measuring device shall be UL listed as an entire assembly.

6. Contractor shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the engineer if any measurement locations do not meet the manufacturer’s placement requirements.

F. Local Control Panels:
1. Indoor control cabinets shall be fully enclosed NEMA 1 construction with hinged door or key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide on and off power switch with over-current protection for control power sources to each local panel.
4. Build control panels in accordance with UL508A standards and label with separate UL label numbers.

G. Current Sensing Relay
1. Current Sensing Relays: Provide solid-state sensor, which operates when the current level sensed by the internal current transformer, exceeds the adjustable trip point. The internal circuits shall be totally powered by induction from the line being monitored. The relay shall have zero off state leakage in the solid-state output while switching both AC and DC circuits. The monitored AC circuits shall be 1 to 150 amps. Veris, Model H908, or approved equal.

H. Flow Meters
1. Shall be Onicon Model F-3100 Series.
2. No substitutes accepted.

I. Electric Meters
1. Shall be Electro Industries/ Gauge Tech, Shark 200 to include V3 switch pack, INP100S 10/100 Base T Ethernet slot, and PO1S pulse outputs/4 status input slot.
2. No substitutes accepted.

J. Gas Meters
1. Shall be Sensus, Sonix 600 or 880 gas meters, utilizing single path ultrasonic metering, with Form A pulse output at 50ms, and a 10 year battery life.
2. 3/8” LCD index display; 4, 5, or 6 digits with 3 digit alarm/ high resolution index.
3. Flash memory: Permanent information retention without power.
4. No substitutes accepted.

K. Network Connection Tool
1. Network connection tool shall allow technician to connect a laptop to any MS/TP network or at any MS/TP device and view and modify all information throughout the entire BACnet network. Laptop connection to tool shall be through Ethernet or PTP.
2. Provide quick connect to MS/TP LAN at each controller. Tool shall be able to adjust to all MS/TP baud rates specified in the BACnet standard.
3. Provide (1) Network Connection Tool for this project.

2.11 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

B. Manufacturers:
1. Belimo

C. Valves: Size for torque required for valve close off at maximum pump differential pressure.

D. Coupling: V-bolt and V-shaped, toothed cradle.

E. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

F. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.

G. Power Requirements (non-Spring Return): 24 V AC.

H. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V DC.

I. Proportional Signal: 2- to 10-V DC, and 2- to 10-V DC position feedback signal.

J. Temperature Rating: 40 to 104 deg F.

K. Standard spring ranges are 2 to 5 PSIG, 3 to 10 psig, and 8 to 11 PSIG.

L. Not pulse actuated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide conduit and wire from dedicated 120 VAC emergency power circuit if available.

B. Power supply wiring (120 VAC) shall be run in dedicated conduit. Power conduit shall be separated from control and signal conduits by a minimum of 3 inches.

C. EMS equipment shall be located such that it is accessible for service while maintaining clearances or walkways required around other equipment or obstacles.

D. Control elements located in outdoor installations shall be weatherproof.

E. Splices in shielded cables shall not be permitted. Terminations of shields and conductors shall be done in accordance with the manufacturer's instructions.

F. Cabling and wiring within panels shall be harnessed with tie wraps and secured in a neat and orderly fashion.

G. Cable runs shall be kept as short as possible, allowing extra length for making connections to termination points.

H. Each cable or individual conductor shall be labeled with a unique tag for quick identification during checkout, testing, and troubleshooting. Each component shall be permanently labeled with the device name and at each terminal point per section.

3.02 EXAMINATION

A. Project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect and Engineer for resolution before rough-in work is started.

B. Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and contractor’s work, and the plans and the work of others—contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the contractor’s work with the work of others. Changes in the work covered by this Specification made necessary by the failure or neglect of contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.03 PROTECTION

A. Contractor shall protect work and material from damage from its work or employees, and be liable for all damages thus caused.

B. Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. Contractor shall protect material that is not immediately installed. Contractor shall close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.04 COORDINATION

A. Site:
1. Where mechanical work will be installed in close proximity to, or will interfere with, work of other trades, contractor shall assist in working out space conditions to make a satisfactory adjustment. If contractor installs its work before coordinating with other trades, so as to cause any interference with work of other trades, contractor shall make necessary changes in its work to correct the condition without extra charge.
2. Coordinate and schedule work with all other work in same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals: Refer to Submittals Article in Part 1 of this Specification for requirements.

C. Test and balance:
1. Contractor shall furnish all tools necessary to interface to the control system for test and balance purposes.

2. Contractor shall provide training in the use of these tools. This training will be planned for a minimum of four hours.

3. In addition, the contractor shall provide a qualified technician to assist in test and balance process, until the first 20 terminal units are balanced.
4. Tools used during the test and balance process will be returned at completion of the testing and balancing.

D. Coordination with controls specified in other sections or divisions: Other sections and Divisions of this Specification include controls and control devices that are to be part of or interfaced to control system specified in this section. Controls shall be integrated into the system and coordinated by contractor as follows:
1. Communication media and equipment shall be provided as specified in Part 2: Communication of this Specification.
2. Each supplier of a control product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section.
3. Contractor shall coordinate and resolve any incompatibilities that arise between the control products provided under this section and those provided under other sections or divisions of this Specification.
4. Contractor is responsible for providing all controls as referenced in the related sections this work of contract documents.
5. Contractor is responsible for the interface of control products provided by multiple suppliers, as referenced in the related sections this work of contract documents.

3.05 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring raceway parallel to the building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electric Code (NEC).

D. Verify wiring integrity to ensure continuity and freedom from shorts and grounds.

E. Equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility, and be executed in strict adherence to local codes and standard practices.

3.06 WIRING

A. Control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification.
Where requirements of this section differ with those in Division 26, the requirements of this section shall take precedence.

B. NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway per NEC and Division 26 requirements.

C. Low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.).

D. Wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage—shall be installed in raceway at levels below 10Ft.

E. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two.

F. Do not install wiring in raceway containing tubing.

G. Class 2 wiring to be installed in conduit.

H. Wire-to-device connections shall be made at a terminal block or terminal strip. Wire-to-wire connections shall be made at a terminal block or wire nut at junction box.

I. Wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

J. Maximum allowable voltage for control wiring shall be 120v. If only higher voltages are available, the contractor shall provide step-down transformers.

K. Wiring shall be installed as continuous lengths, with no splices permitted between termination points.

L. Size of raceway and size and type of wire shall be the responsibility of contractor, in keeping with the manufacturer’s recommendation and NEC requirements, except as noted elsewhere.

M. Include one pull string in each raceway 1 inch or larger.

N. Use coded conductors throughout with different colored conductors.

O. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6inch from high-temperature equipment (e.g., steam pipes or flues).

P. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

Q. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.

R. Contractor shall terminate control and interlock wiring, and maintain updated wiring diagrams with terminations identified at the job site.

S. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture—including chiller and boiler rooms—liquid-tight, flexible metal raceways shall be used.

T. All conduits on roof or exposed to weather to be rigid.

U. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends and left clean and free of obstructions. Raceway sections shall be joined with couplings (per code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.07 COMMUNICATION WIRING

A. Contractor shall adhere to items listed in Wiring Article in Part 3 of Specification.

B. Follow manufacturer's installation recommendations for communication cabling.

C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during the installation.

E. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor shall be installed between the lines and ground. Lightning arrestor shall be installed according to the manufacturer's instructions.

G. Runs of communication wiring shall be unspliced lengths when that length is commercially available.

H. Label communication wiring to indicate origination and destination data.

3.08 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Specification.

B. Contractor shall continually monitor the field installation for code compliance and quality workmanship.

C. Contractor shall have work inspected by local or state authorities having jurisdiction over the work.

3.09 IDENTIFICATION OF HARDWARE AND WIRING

A. Wiring, cabling, and tubing within factory-fabricated panels shall be labeled within 2 inch of termination with point address or termination number.

B. Label pneumatic tubing at each end within 2 inch of termination with descriptive identifier.

C. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.

D. Manufacturers’ name plates and UL or CSA labels are to be visible and legible after equipment is installed.

E. Identifiers shall match record documents.

F. Permanently label or code each point of field terminal strips to show instrument or item served.

G. Identify room sensors relating to air handling units and terminal air units with nameplates.

H. Label wiring and conduit, including wire within panels.

I. Electrical devices such as transformers and power supplies shall be labeled with supply voltage and power circuit number.

J. Terminal blocks shall be labeled to match the connected device.

K. Label panel-mounted devices to match as built drawings.

L. Wire and tubing labels shall be clearly indicated on the control drawings. Method of labeling shall be logical and intuitive.

M. Provide label on ceiling grid near each terminal air unit, and air and water pressure transducers in the ductwork and piping. Follow campus standard for type and appearance of label.

3.10 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25 percent of available memory free for future use.

B. Point naming and point value: System point names and values shall be of sufficient size to allow flexibility in design, allowing easy operator interface without the use of a written point index or cryptic alphanumeric shorthand.
   1. Point ID is used to designate the location of the point within the building, such as mechanical room, wing, or level, or the building itself in a multi-building environment. Point ID shall be a minimum of 40 characters in length.
   2. Point descriptors shall be a minimum of 132 characters.
   3. Point states shall be a minimum of 8 characters in length.
   4. Point engineering units shall be a minimum of 6 characters in length.
   5. Point values shall be a minimum of 15 characters in length with a variable decimal point.

C. Operator interface:
   1. Standard graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, fan coil unit, terminal equipment and all life safety devices. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
   2. Show terminal equipment information on a graphic summary table. Provide dynamic information for each point shown.
   3. Program graphic screens to show the location of, alarm points, and cameras. Set up these screens to provide automatic camera call up upon alarm.
   4. Contractor shall provide labor necessary to install, initialize, start up, and troubleshoot all operator interface software and their functions as described in this section. This includes any operating system software, operator interface database, and any third-party software installation and integration required for successful operation of the operator interface

3.11 BUILDING CONTROL INSTALLATION SPECIFICS

A. Installation of sensors
   1. Install sensors in accordance with the manufacturer’s recommendations.
   2. Mount sensors rigidly and adequately for the environment within which sensor operates.
   3. Room temperature sensors shall be installed on concealed junction boxes properly supported. Wiring to the sensor shall not be required to be polarity sensitive. Design of sensor shall be modular, which allows for rough-in of wiring without presence of electronics or esthetic covering.
   4. Wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

B. Flow switch installation
   1. Use correct paddle for pipe diameter.
   2. Adjust flow switch in accordance with manufacturer’s instructions.

C. Actuators
   1. Mount and link control damper actuators per manufacturer’s instructions.
      a. Check operation of damper and actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
      b. Provide mounting hardware and linkages for actuator installation.
   2. Electric and electronic actuators:
      a. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. Actuators shall be mounted following manufacturer’s recommendations.
      b. Valves: Actuators shall be connected to valves with adapters approved by actuator manufacturer. Actuators and adapters shall be mounted following actuator manufacturer’s recommendations.

3.12 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup testing: Testing listed in this Article shall be performed by contractor and make up part of the necessary verification of an operating control system. Testing shall be completed before the Owner’s representative is notified of the system demonstration.

1. Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment furnished under this Specification.
2. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
3. Enable control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers’ recommendations.
4. Verify that digital output devices (relays, solenoid valves, two-position actuators and control valves, and magnetic starters) operate properly and that normal positions are correct.
5. Verify that analog output devices (I/Ps, actuators) are functional, that start and span are correct, and that direction and normal positions are correct. Contractor shall check all control valves and automatic dampers to ensure proper action and closure. Contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that system operation adheres to the Sequences of Operation. Simulate and observe modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start and stop routines.
7. Analog intelligent devices shall be tested for current address, sensitivity and user defined message
8. Verify activation of all water-flow switches.
9. Open initiating device circuits and verify that the trouble signal actuates.

3.13 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:
1. Prior to acceptance, control system shall undergo a series of performance tests to verify operation and compliance with this Specification. Tests shall occur after the contractor has completed the installation, started up the system, and performed its own tests.
2. Tests described in this section are to be performed in addition to tests that contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the Control System Checkout and Testing Article in Part 3 of this Specification.
   Engineer will be present to observe and review these tests. Notify Engineer at least 10 days in advance of the start of the testing procedures.
3. Demonstration process shall follow that approved in Part 1: Submittals. Approved checklists and forms shall be completed for all systems as part of the demonstration.
4. Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate field operation of each control and sensing point for modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, alarm, trouble, and power failure modes. Purpose is to demonstrate the calibration, response, and action of every point and system. Test equipment required to prove operation of system shall be provided and operated by contractor.
5. Complete a log showing the date, technician’s initials, and any corrective action taken or needed for each control input and output checked.
6. Demonstrate compliance with Part 1: System Performance.
7. Demonstrate compliance with Sequences of Operation through all modes of operation.

8. Demonstrate the following items:
   a. Complete operation of the operator interface
   b. DDC Loop response: Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. Test shall show the loop’s response to a change in set point that represents a change of actuator position of at least 25 percent of its full range. Sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. For each sample, the trend data shall show the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by contractor.
   c. Demand limiting (if implemented): Contractor shall supply a trend data output showing the action of demand limiting algorithm. Data shall document action on a minute-by-minute basis over a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
   d. Optimum start and stop (if implemented): Contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trends shall include output status of optimally started and stopped equipment, and area temperature sensor inputs.
   e. Interface to the building fire alarm system (if implemented).
   f. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Architect and Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. Provide logs in both printed and disk formats.
9. Tests that fail to demonstrate operation of the system shall be repeated at a later date. Contractor shall be responsible for necessary repairs or revisions to hardware or software to successfully complete tests.

B. Acceptance:
1. Tests described in this Specification shall have been performed to the satisfaction of the Engineer and Owner prior to acceptance of the control system as meeting the requirements of completion.
   Tests that cannot be performed due to circumstances beyond the control of contractor may be exempt from completion requirements if stated in writing by the Engineer. Tests shall then be performed as part of the warranty.
2. System shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: Submittals.

3.14 CLEANING

A. Contractor shall clean up all debris resulting from its activities daily. Contractor shall remove all cartons, containers, and crates under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At completion of work in any area, contractor shall clean all of its work and equipment, keeping it free from dust, dirt, and debris.

C. At the completion of work, equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.15 SYSTEM TESTING AND CHECKOUT

A. Prior to the acceptance test, perform the following tasks:
   1. Check for electrical continuity, eliminating shorts and open circuits, and verify grounding.
   2. Install, calibrate, adjust, debug and set system's initial operating parameters including the existing campus central server.
   3. Check out systems to verify the provided engineering documentation and approved submittals have been followed.

B. The EMS must operate continuously for seven (7) days with no operational malfunctions or problems before setting an acceptance test date. Simulate different building control scenarios for worst-case condition and simulate other alarm conditions to test the response and handling of situations.

C. Prepare and submit an Acceptance Test Plan for approval. This test shall include verification of communications, control, and response from the existing campus central server to the building controller and finally to the sensor and controlled device to demonstrate the proper operation of control loops, conditional control and default sequences in accordance with the project documentation.

D. Obtain the approval of the Rio Hondo College representative as to when the acceptance test will be performed.

E. Conduct the acceptance test in the presence of the designated representative for Rio Hondo College following the approved Acceptance Test Plan.

F. The College’s Representative shall check off and initial each successfully tested item. Demonstrate that the electromechanical systems are operating properly and that the system is providing the required control sequences, alarms, graphic displays, and report generations.

G. An ongoing punch list shall be maintained throughout the test of items. This list shall contain items that must be corrected prior to accepting the system for beneficial use and commencement of the warranty period.

H. Provide copy of database of objects, and any programming tools used during the setup of the system.

3.16 TRAINING

A. Furnish the services of competent instructor(s) who shall give a minimum of (16) hours onsite instruction and orientation to the College’s designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements of the equipment, the affected systems, and the software provided. The training shall be customized to reflect the actual system installed rather than being a general training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach.

B. Train designated staff of Owner’s representative and Owner to enable them to:
   1. Day-to-Day Operators:
      a. Proficiently operate the system
      b. Understand control system architecture and configuration
      c. Understand system components
      d. Understand system operation, including system control and optimizing routines (algorithms)
      e. Operate the workstation and peripherals
      f. Log on and off the system
      g. Access graphics, point reports, and logs
      h. Adjust and change system set points, time schedules, and holiday schedules
      i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
      j. Understand system drawings and the Operation and Maintenance manual
      k. Understand the job layout and location of control components
      l. Access data from various network and control nodes.
      m. Operate portable operator’s terminals
   2. Advanced operators:
      a. Make and change graphics on the workstation
      b. Create, delete, and modify alarms, including annunciation and routing of these
      c. Create, delete, and modify point trend logs, and graph or print these both on an ad-hoc basis and at user-definable time intervals
      d. Create, delete, and modify reports
      e. Add, remove, and modify system physical points
      f. Create, modify, and delete programming
      g. Add panels when required
      h. Add operator interface stations
      i. Create, delete, and modify system displays—both graphical and otherwise
      j. Perform system field checkout procedures
      k. Perform controller unit operation and maintenance procedures
      l. Perform workstation and peripheral operation and maintenance procedures
      m. Perform system diagnostic procedures
      n. Configure hardware including PC boards, switches, communication, and I/0 points
      o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
      p. Adjust, calibrate, and replace system components
   3. System managers and administrators:
      a. Maintain software and prepare backups
      b. Interface with job-specific, third-party operator software
      c. Add new users and understand password security procedures

C. These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on the level of knowledge required:
   1. Day-to-day operators
   2. Advanced operators
   3. System managers and administrators

D. Provide course outline and materials as per Submittals Article in Part 1 of this Specification. Instructor(s) shall provide one copy of training material per student.

E. Instructor(s) shall be factory-trained experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of the installed hardware.

PART 4 - POINTS LIST AND SEQUENCE OF OPERATION

4.01 Refer to Controls Drawings for control schematics, points lists and Sequence of Operation.

END OF SECTION 23 0923

SECTION 23 3616

SINGLE DUCT AIR TERMINAL UNIT

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.

1.02 SUMMARY

A. This Section includes the Single-duct air terminals (VAV) units.

B. Related Sections include the following:
1. Division 23 Section "HVAC Insulation" for external insulation of air terminals.
2. Division 25 Section "Automatic Temperature Control Systems" for control devices installed on air terminals.

1.03 SUBMITTALS

A. Product Data: Include rated capacities and performance of unit and heating-coil; shipping, installed and operating weights; furnished specialties; and accessories for each model indicated. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.

B. Test Result: See Paragraph 2.3 –A.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
1. Retain subparagraph below if equipment includes wiring.
2. Wiring Diagrams: Detail wiring for Power, signal and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating air outlets with other items installed in ceilings.

E. Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide to include in the maintenance manuals specified in Division 01.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics and project requirements may be considered. Refer to Division 01 Section "Substitutions."

B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
   2. Subparagraph below is required by some Federal agencies.
   3. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

D. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
   1. Nailor Industries Inc.
   2. Air System Components; Krueger Div.
   3. Anemostat Products Div.
   4. Titus

2.02 SINGLE DUCT AIR TERMINALS

A. Configuration: Volume-damper assembly inside unit casing with factory installed hanger brackets. Locate control components inside protective metal shroud provided by unit manufacturer.

B. Casings: Steel or aluminum sheet metal of the following minimum thicknesses:
   1. Upstream Pressure Side: 0.0239-inch steel.
   2. Downstream Pressure Side: 0.0179-inch steel.
   3. Upstream Pressure Side: 0.032-inch aluminum.
   4. Downstream Pressure Side: 0.025-inch aluminum.

C. Casing Lining: Minimum of 1/2-inch-thick, neoprene- or vinyl-coated, fibrous-glass insulation; 1.5-lb/cu. ft. (24-kg/cu. m) density, complying with NFPA 90A requirements and UL 181 erosion requirements. See paragraph 2.04 for sound power requirements which may require greater lining than ½” thickness. Secure lining to prevent de-lamination, sagging, or settling.
   1. Cover liner with perforated metal.

D. Plenum Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.

E. Plenum Air Outlets: S-slip and drive connections.

F. Access: Removable panels to permit access to dampers and other parts requiring service, adjustment, or maintenance, with airtight gasket and cam lock bottom access panel.

G. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: 2 percent of nominal airflow at design inlet static pressure.
   2. Damper Position: Normally open.

H. Provide field assembled lined outlet plenum as detailed on mechanical drawings.

I. Hot-Water Heating Coil: 1/2-inch (13-mm) copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 PSIG; and factory installed.

J. Controls: Damper operator, thermostat, and other devices compatible with Automatic temperature controls system as specified in Section 230923.

K. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor provide control with the following features:
   1. Proportional plus integral control of room temperature.
   2. Time-proportional reheat-coil control.
   3. Occupied/unoccupied operating mode.
   4. Remote reset of airflow or temperature set points.
   5. Adjusting and monitoring with portable terminal.
   6. Communication with automatic temperature control system specified in other Section 230923 of this specification book.
   7. See mechanical drawings for more requirements.

2.03 SOURCE QUALITY CONTROL

A. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals." The result of test shall be certified by the independent testing agency or an ARI approved testing laboratory and submitted to the architect for approval. The submittal shall include a complete description of the test conditions, methods and procedures.

B. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal. Identify each VAV box above ceiling with plan number using a permanent labeling system to satisfaction of architect.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance.

B. Connect ductwork to air terminals according to Division 23 ductwork Sections and details on mechanical drawings.

3.02 CONNECTIONS

A. Install piping adjacent to air terminals to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," and mechanical details and diagrams on construction drawings, connect heating coils to supply piping with shutoff valve, strainer, control valve, union / flange and flexible connector; and to return piping with flexible connector, balancing valve and union or flange and 3-way temperature control valve.

C. Ground equipment.
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.05 COMMISSIONING

A. Verify that installation of each air terminal is according to the Contract Documents.

B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

C. Check that controls and control enclosure are accessible.

D. Verify that control connections are complete.

E. Check that nameplate and identification tag are visible.

F. Verify that controls respond to inputs as specified.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
   1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
   2. Review data in the maintenance manuals. Refer to Division 01 Section "Contract Closeout."
   3. Review data in the maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
   4. Schedule training with Owner, through Architect, with at least 7-day advance notice.

END OF SECTION 23 3616

SECTION 23 3713

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Types of outlets and inlets required for project include the following:

1. Linear slot diffusers and returns.
2. Ceiling air diffusers, rectangular, square, round.
3. Wall registers and grilles.

1.02 RELATED SECTIONS

A. Refer to other Division 23 Sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

B. Refer to other Division 23 Sections for balancing of air outlets and inlets; not work of this section.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, quantity furnished, model number, size, and accessories furnished.
2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.
4. ANSI/ASHRAE Standard 70-1991.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver air outlets and inlets wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors, when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

1.05 QUALITY ASSURANCE

A. Codes and Standards:

1. ANSI/ASHRAE Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ANSI/ASHRAE Standard 70-1991.
2. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

PART 2 - PRODUCTS

2.01 CEILING AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of ceiling air diffuser.

2.02 MANUFACTURER

A. Subject to compliance with requirement diffusers of one of the following:

1. Krueger Mfg. Co.
2. Nailor Industries, Inc.
3. Titus Air Distribution Products
4. Anemostat Air Distribution Products

B. Manufacturers and model numbers are listed and/or scheduled to set a standard of quality. Equivalent manufacturers and models accepted by Architect/Engineer may be used. Equivalents must be submitted for review.

1. Equivalents: Other manufacturers offering a similar product which is in accordance with the design criteria indicated may be submitted upon architect’s written acceptance prior to bidding. The cost to conduct all tests as may be directed by the architect to demonstrate that the equivalent product can achieve the criteria indicated, including all travel costs, shall be borne by the submitting contractor.

2.03 LINEAR SLOT DIFFUSER AND RETURN

A. General: Provide acoustical ceiling air distribution system. Consisting of ceiling slot air diffusers, base-frames, air chambers and entry collars.

B. Air Distribution Base Frames:

1. Linear air diffusers base frames shall mechanically lock into the grid system. The base frames shall be extruded aluminum sections. Length shall be 48" unless otherwise noted or required.

2. Provide air distribution base frame with full supply air pattern control air weir gates. When used for return air, these air weir gates act as a return airflow control damper. Close air weir gates where return is not necessary.
3. Base frame shall present a substantially uniform appearance through the air slot when used as supply, returns or fully closed. All interior portions of the throat, including the vertical stems of the extrusions, shall be painted flat black to prevent unsightly visual deviations. Paint all exposed surfaces baked white enamel. Base frame shall be compatible with type of ceiling where linear slot diffuser is installed.
4. Base frame shall be provided with spacer channels located on the ceiling module. The spacer channel shall act as the support means for the adjustable full pattern control air weir gates, which are provided throughout the entire length of the base frame.
5. The noise criteria of the air distribution base frame shall be expressed in sound power levels (decibels 10-12 watts) in octave bands 2 through 7 with a room attenuation of 10 decibels and shall not exceed noise-criteria of 30. All data shall be based on tests performed in a certifiedlaboratory.
6. Where noted on drawings or as required, blank-off airtight backside of supply air linear slot where duct connection is not made.

C. Supply or Return Air Chambers:

1. Supply or Return air plenum chambers shall be designed, tested, and fabricated by the same manufacturer that furnishes the base frames. Shop fabricated air chambers not acceptable. Provide with damper at inlet to plenum, which is accessible through face of linear diffuser for adjustment.
2. Provide adjustable air pattern controllersthat are accessible through the base frame slot for field adjustment of the spread of the air stream. This will be accomplished without the removal of acoustical tile.
3. Provide a round neck air entry collar sized for maximum average air entry velocity of 750 FPM. A volume damper shall be installed at connection to plenum, which is accessible through face of diffuser for adjustment.
4. Construct supply air chamber from not less than 26 gauge galvanized steel and will be lined with one- quarter inch 2 lb./cu. ft.density thermal acoustical insulating. All surfaces visible through the slot will be painted flat black.
5. Provide spring clip keepers to securely attach the chamber to the base frame when in operation. These spring clips permit releasing of the air chamber for easy relocation.
6. The supply air chamber shall have been tested as composite assembly with the linear base frame for air distribution and noise level performance. The tests shall be conducted in accordance with ANSI/ASHRAE Standard 70-1991.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Coordinate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

D. Supply outlets to provide the required air throw and spread with no apparent drafts or excessive air movement within space being supplied. Contractor to provide necessary accessories to accomplish satisfactory air distribution.

E. Provide felt, cork or rubber gasket between finish-surface and frame to prevent vibration and assure tight fit. Contractor shall be responsible for the correct location of ductwork and outlets.

F. For filler panel type outlets the manufacturer shall coordinate his design with the ceiling suspension system being used. The Contractor and manufacturer shall match up sizes of outlets to properly fit in ceiling systems, between concrete or masonry components, between architectural items before fabrication.

G. When installing removable core type outlets, secure to frame with screws.

H. Secure outlets to ceiling suspension systems as required by Division of the State Architect.

END OF SECTION 23 3713

SECTION 23 7513

AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Section includes factory fabricated Custom Air Handling Units, associated accessories, fan and coil unit.

B. Design, performance criteria, controls, and installation requirements for Custom Air Handling Units.

1.02 CODES AND STANDARDS

A. American Bearing Manufacturers Association
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.
1. AMCA 99 - Standards Handbook.
2. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
6. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. Air-Conditioning and Refrigeration Institute
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
2. ARI 430 - Central-Station Air-Handling Units.
3. ARI 610 - Central System Humidifiers for Residential Applications.
4. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.

D. National Electrical Manufacturers Association
1. NEMA MG 1 - Motors and Generators.

E. National Electrical Code
1. NFPA 70.

F. Sheet Metal and Air Conditioning Contractors
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

G. Underwriters Laboratories Inc.
1. UL 900 - Air Filter Units.
2. UL - Fire Resistance Directory.

1.03 QUALITY ASSURANCE

A. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.

B. Damper Leakage: Test in accordance with AMCA 500.

C. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.04 RELATED SECTIONS

A. Refer to other Division 23 Sections for vibration control units used in conjunction with air-handling units; not work of this section.

B. Vibration control units required for air handling units is specified in other Division 23 Sections, and is included as work of this section.

C. Refer to other Division 23 Sections for hot and chilled water, natural gas, and condensate drain piping required in conjunction with air handling units; not work of this section.

D. Refer to Division 23 specification Section for “Maximum Sound power Level for Fan Equipment”.

1.05 SUBMITTALS

A. Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

B. Submittal shall include the following:
   1. Dimensioned plan and elevation view drawings, including motor starter VFDs and control cabinets, required clearances, and location of all field connections.
   2. Summary of all auxiliary utility requirements such as: electricity, water, compressed air, etc. Summary shall indicate quality and quantity of each required utility.
   3. Ladder type schematic drawing of the power and ancillary utility field hookup requirements, indicating all items that are furnished.
   4. Manufacturer’s performance of each unit. Selection shall indicate, as a minimum, the following:
      a. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
      b. Input data used for selection.
      c. Model number of the unit.
      d. Net capacity.
      e. Rated load amp draw.
      f. Noise levels produced by equipment.
      g. Fan curves.
      h. Approximate unit shipping weight.
      i. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
      j. Fans: Performance and fan curves with specified operating point plotted, power, RPM.

k. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
l. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
m. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

C. Maintenance Data: As part of the submittal package, include data on design, inspection and procedures related to preventative maintenance. Including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, and shop drawings, in maintenance manuals; in accordance with requirements of Division 01.

D. As part of the submittal package, include Manufacturer's Installation Instructions.

E. As part of the submittal package, include Manufacturer's Certificate, certifying submitted products meet or exceed specified requirements.

1.06 OPERATION AND MAINTENANCE DATA

A. Operation and Maintenance manuals including but not limited to “Maintenance Data” requirements per paragraph 1.05-c shall be submitted at the time of unit shipment.

1.07 QUALIFICATIONS

A. Manufacturer shall be a company specializing in the design and manufacture of commercial / industrial custom air handling units as specified herein after. Manufacturer shall have been in production of commercial / industrial custom air handling units for a minimum of 15 years.

B. Each unit shall bear an ETL or UL label under UL Standard 1995 indicating the complete unit is listed as an assembly. ETL or UL listing of individual components, or control panels only, is not acceptable.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery air handling units with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle air handling units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air handling unit manufacturer.

C. Store air handling units in clean dry place and protect from weather and construction traffic.

D. Comply with Manufacturer's rigging and installation instructions for unloading air handling units, and moving them to final location.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

1.10 WARRANTY

A. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start upon receipt of final acceptance by owner of the start-up forms for the unit or twenty four months after the date of shipment, whichever occurs first.

B. The installing contractor shall provide labor warranty during the unit’s first year of operation.

1.11 EXTRA MATERIAL

A. Furnish in original packaging from manufacturer and label each spare part to match the air handler unit tag the following spare parts for each air handler unit;
   1. One complete set of filters for each air handler.

PART 2 -PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide custom outdoor air handling units as manufactured by Temtrol Model ITF as the basis-of- design. Approved equal manufacturers would be; Governair,Huntair, Dynamic Air Technology. Request for substitution shall be approved 30 calendar days before the bid date. All Manufacturers shall meet the specifications, capacities and performance criteria set forth in construction documentations and specifications.

2.02 GENERAL

A. Furnish and install where shown on the plans, mechanical frame style air handling units specifically designed for OUTDOOR application, with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

B. All major components such as fans, coils, dampers, etc… shall be provided from sole source inside USA. Provide the list of suppliers and associated lead times for each component.

C. Air handling units shall meet the seismic design requirements set forth in the International Building Code (IBC 2009). Equipment manufacturer shall provide certificate of compliance stating units have been certified for the seismic requirements indicated on the structural drawings and in accordance with ASCE 7-10 / ICC-ES AC-156. Unit certification shall be based on a maximum SDS value of 1.93g. Certification of the Air Handling Equipment shall be through engineering analysis performed by an independent registered professional consulting engineer specializing in seismic analysis. The analysis performed shall include structural calculations, static and dynamic finite element analysis and shake table testing in accordance with ASCE-7-10 / ICC-ES-AC-156.A Copy of the Seismic Certification shall also be submitted as part of the submittal requirements for review and approval. The air handler shall be provided with IBC Compliant Labeling.

2.03 FACTORY TESTING AND QUALITY CONTROL

A. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.

2.04 UNIT CONSTRUCTION DESCRIPTION

A. General: Provide factory-fabricated outdoor air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

B. Unit Base - Floor: Unit perimeter base shall be completely welded and fabricated using heavy gauge structural steel tubing. (Note: bolted bases are not acceptable) C-Channel cross supports shall be welded to perimeter base steel tubing and located on maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs welded to perimeter base at the corner of the unit or each section if de-mounted. Entire base frame is to be painted with a phenolic-coating for long term corrosion resistance. Internal walk-on floor shall be thermal break construction, mechanically fastened, caulk seams. 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seam gaskets for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic-coated steel safety grating. Single wall floors with glued and pined insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.

C. Unit Casing – The construction of the air handling unit shall consist of a (1" x 2") formed steel frame to form a strong infrastructure steel frame with formed 16 gauge galvanized steel exterior casing panels. The exterior casing panels shall be attached to the gasket (1 x2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing-panels are made from 14 Gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 9" positive pressure). The air handling unit casing shall be of the "no-through-metal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully

assembled, there’s no path of continuous unbroken metal to metal conduction from inner to outer surfaces. Provide necessary support to limit casing deflection to L/200 of the narrowest panel dimension. If panels cannot meet this deflection, additional internal reinforcing is required. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1% at design static pressure or 9” W.C. whichever is greater.

D. The exterior panel finish shall be painted with a polyester resin coating designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at 95 degrees F. 2,500 hrs. And (ASTM D-2247) Humidity Resistance at 95 degrees F. 2,500hrs. The color shall be sandstone.

E. Double Wall Liner - Each unit shall have double wall construction with 0.040 aluminum liner in the entire unit. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.

F. Insulation - Entire unit shall be insulated with a full 3” (R12.5)thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of 0.24 (BTU in/sq ft F°) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88) and meet NFPA 90A and 90B. All insulation edges shall be encapsulated within the panel. All perforated sections shall have Micromat® or equal insulation with non-woven mat facing, 5000 fpm rating and non-hygroscopic fibers as manufactured by Johns Manville or approved equal.

G. Weatherproof construction shall consist of a third waterproof panel over the roof of the double wall panel to make the unit weather tight.

H. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be completely adjustable die cast stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
   1. Provide thermal break door design.
   2. Access doors in the fan section shall be provided with a 10 x 10 dual thermal pane safety glass window.

2.05 UNIT COMPONENT DESCRIPTION

A. Fans: All fans shall meet the air flow performance specified and shall not exceed the break horsepower or sound power levels specified on the mechanical equipment schedule. Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300. All fans shall have a steep pressure/volume curve. Fan shaft shall be turned, ground and polished solid steel rated at maximum RPM below critical speed. Fan wheel and sheaves shall be keyed to the shaft. Fan shall be balanced per ANSI / AMCA 204-96 fan application category BV-3 using a digital signal analyzer at the design RPM with belts and drives in place to a vibration velocity less than or equal to 0.157 inches per second measured horizontal and vertical at each bearing pad. Vibration amplitudes are in inches/second-Peak. All values are filter-in at

the fan speed. Fan assemblies shall be designed for heavy-duty industrial applications. Fan framing assemblies shall be fabricated from structural steel. Formed load bearing members are not acceptable. The structural steel shall be electrically welded together to form a rigid integral base. Fan assemblies shall be independently isolated with spring-type vibration isolators. Inlet cones shall be precision spun or die formed. Inlet cones shall be aerodynamically matched to the wheel side plate to provide streamlined airflow in the wheel and ensure full loading of the blades.

1. The multiple fan array systems shall include multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified class III as required. Class I fans are not acceptable. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan’s peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 14 gauge, G 90U Galvanized steel intake wall, 14 gauge spun steel fan inlet funnel, and an 10 gauge G90 Galvanized steel motor support plate rail and structure. All motors shall be standard foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor, Siemens, or Toshiba for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed (L10-400,000 hr) bearings and AEGIS™ shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .022” per second peak, filter in (.55mm per second peak, filter in). Fan and motor assemblies submitted for approval incorporating larger than 22” wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022” per second peak filter in (.55 mm per second peak, filter in). Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of shipment. Submittals that do not include a statement of compliance with this requirement will be returned to the contractor without review.
2. The fan array shall consist of multiple fan and motor ”cubes” or “cells”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross sectional area of the AHU air way tunnel. There shall be no blank off plates or “spacers” between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by +/- 10% when measured at a point 36” from the intake side of the fan array intake plenum wall, and at a distance of 72” from the discharge side of the fan array intake plenum wall. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for pre-bid approval that indicates uniform velocity and flow across all internal components

without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.

3. Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back flow prevention device(s) shall be included in the criteria for TSP determination for fan selection purposes, and shall be indicated as a separate line item SP loss in the submittals. Submitted AHU performance that does not indicate allowance for system effects for the back flow prevention device(s) and the system effect for the fan and motor enclosure in which each fan is mounted , will be returned to the contractor disapproved and will need to be resubmitted with all of the requested information included for approval. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan. Motorized dampers for this purpose are not acceptable. Submitted fan performance data which only reflect published performance for individual fans in AMCA arrangement “A” free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with Back Draft damper effects included. At the sole discretion of the engineer, such performance testing may be witnessed by the engineer and/or the owner’s representative.
4. Each fan motor shall be individually wired to a control panel with individual Motor Protection for thermal overload protection. All motor circuit protectors can be located in starting device enclosure or, if required by design, in a separate enclosure. Motor circuit protector enclosure must be located and mounted at a minimal distance from motors in the FANWALL Array. Provide remote indication by means of aux contacts wired in series. Pilot Lights: Multiple (one per fan) cover mounted pilot lights for local monitoring.
5. As required by system design, provide one ABB ACH550Variable Frequency Drive for normal operation and a second ABB ACH550Variable Frequency Drive for Redundant Backup operation. Provide control wiring and control circuitry to transfer from main VFD to Redundant VFD when main drive has faulted. The Variable Frequency Drives shall be sized accordingly to start and hold all motors in the FANWALL Array. Provide service disconnect with circuit breaker. As required by system design, each fan assembly shall be equipped with airflow monitoring probes. The flow measuring system shall consist of a flow measuring station with two static pressure taps located at the throat of the fan inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator shall provide an output control signal transmitter (4-20mA) (0-10 volt) for use in BAS as specified elsewhere.
6. At the sole discretion of the engineer, AHU manufacturers that are approved for bidding purposes only, other than the basis of design manufacturer, and that are submitting multiple fan arrays, shall test one or more of the submitted AHU’s for flow, pressure, leakage, BHP and acoustics as submitted and approved, prior to shipment. The testing shall be witnessed by an owner’s representative and approved by the engineer prior to shipment of any of the submitted AHU equipment. A test report shall be provided for each tested AHU unit and the report shall be included in the O&M manuals for the units.

7. Each fan & motor assembly shall be removable through a 24” wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor.
8. VFDs – Variable Frequency Drives shall be per requirements of specification section 23 0520, ABB Model ACH550. Each supply and return fan shall be provided with separate variable frequency drives. Drives shall be factory mounted inside the air handler unit with adequate ventilation provided. The variable frequency drive shall convert 460 volt +/- 10%, three phase, 60 hertz (+/- 2 Hz.) utility power to adjustable voltage/frequency, three phase, A-C power step less motor control from 5% to 105% of base speed. The variable frequency drive (VFD) shall produce an adjustable A-C voltage/frequency output of complete motor speed control and an input power factor near unity over the entire speed range. The VFD shall be automatically controlled by a control signal. The VFD shall be self contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0 and 40 ° Celsius. The VFD shall be UL listed. Components used in all options shall be UL listed. The VFD shall have a hand/off/auto operator switch, drive switch with run or stop command and panel mounted digital display capable of indicating unit status, frequency, and fault diagnostics.

B. Heat Transfer Coils – Water Coil
1. All coil assemblies shall be leak tested under water at 315 PSIG and PERFORMANCE is to be CERTIFIED under ARI Standard 410. Coils exceeding the range of ARI standard rating conditions shall be noted.
2. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.
3. Headers are to be seamless copper with die formed tube holes.
4. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided on coil header for coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.
5. Water coils shall have the following construction:
   a. 5/8" O.D. x .020" wall copper tube with .028 return bends,
   b. 0.008" aluminum fins,
   c. 16 gauge 304stainless steel casing.

C. Condensate / Drain Pans - IAQ style drain pans shall be provided under all cooling coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All-pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4” MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage.

D. Filters - Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by BLC, FARR or equal. Filter racks over 72" in length shall require an angle center reinforcement support.

Side service filter racks shall be fabricated from no less than 16 gauge galvanized steel and include hinged access doors on both sides of the unit or as indicated on unit drawings. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters.

1. Filter Gauge: Each Filter bank shall be furnished with Dwyer Series 2000 filter gauge or equal.
2. Provide filters as specified on filter schedule. The filters shall be as manufactured by AAF, FARR or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.

E. Dampers –Temtrol TD-6, Ruskin CD-50 or approved equal. Provide Class 1 rated, ultra low leak dampers (less than 3 CFM/sq ft. @ 1” W.G.) as indicated on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santo-prene rubber edge seals and zinc plated or stainless steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical – non corrosive nylon to eliminate friction and any metal to metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge galvanized steel frame. Coordinate operator requirement with Division 25.

F. Air Monitoring Station: The outside air flow monitoring station for minimum air and 100% air flow shall combine the functions of Ruskin AMS50 control damper and flow measurement station in one assembly.

G. Louvers

1. Exhaust Air applications –Ruskin ELF 6375 DX stationary louvers, drainable type with built in downspouts and bird-screen. Blades shall be housed inside a 16 Ga. galvanized steel frame mounted to the unit exterior. Louver finish to match exterior unit finish.
2. Outside Air applications - RUSKIN EME3625D extruded aluminum louvers shall be used at O/A location. Louvers shall be stationary, drainable type with built in downspouts and furnished with bird-screen. Blades shall be vertical and housed inside an aluminum frame mounted to the unit exterior. Louver finish to match exterior unit finish.

2.06 ELECTRICAL POWER AND CONTROLS

A. Electrical shall be 460V power to each fan section and a single 120V power for the UV lights and a single 120V for the lights and convenience outlet. Actuators are field wired.

B. The unit shall feature a main non-fused disconnect of the proper amp rating to allow shutoff of all electrical motors and control items.

C. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed.

D. All wiring shall be (75°C) Insulated copper wires.

E. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number, CFM, fan HPs, and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.

F. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquid-tite flexible metal conduit may be used outside the air tunnel for wet locations.

G. The unit shall feature a main non-fused disconnect of the proper amp rating to allow shutoff of all electrical motors and control items.

H. A Recessed compartment shall be furnished on the (end / side) of the unit. The compartment shall be ventilated with supply air from the unit to provide adequate cooling of electrical components mounted within. Access doors(s) shall be furnished on the unit exterior to provide service to all components.

I. Unit Convenience Features
1. Each section shall be equipped with a vapor- proof 100 watt service light with guard.
2. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door.
3. Furnish a 120 volt GFI duplex convenience outlet on the exterior of the unit. Coordinate with Division 26.
4. All lights, switches and outlets shall be wired to a fused or non-fused disconnect for a separate 120 volt external source. Coordinate with Division 26.

J. Smoke Detector – A factory mounted and wired reset ionization type smoke detector(s) located in supply air stream shall be provided.

K. UV Lights
1. The air handling unit manufacturer shall furnish and install, including interconnecting wiring and safety interlocks, a germicidal UVC irradiation system for each air handler. A heavy-duty UVC germicidal irradiation system using short wave UVC germicidal lamps shall be furnished with each air handler.
2. Intensity: The minimal UV energy striking a targeted surface shall be sufficient to destroy a monolayer of common mold and fungi within six hours.
3. Lamps and fixtures are to be installed in sufficient quantity and in such a manner to ensure equal distribution of UV energy across the cooling face and drain pans.
4. Lamps: Each lamp shall contain no more than 8 milligrams of mercury consistent with current environmental practices and shall be capable of producing its specified output in temperatures of 55 - 135° and airflow velocities up to 1000 fpm. Useful lamp life shall be 9,000 hours with no more than 20% output loss at the end of one year, continuous use. Lamps shall be constructed of UV proof metal bases and shall not product ozone or other secondary contamination.
5. Fixtures: Each fixture shall be constructed of stainless steel. Galvanized steel or aluminum is not acceptable. All integral parts of the fixture shall be self-contained. Fixtures constructed to UL drip proof design and equipped with safety approved fixture-to-fixture plugs to facilitate UL approved multiple fixture and row coupling to A/C power. The UV assembly shall include mechanical interlocks to prevent energizing unless the system is properly installed.

6. Power Supplies: The power supply shall be electronic, high-efficiency type capable of producing the required coverage at no more than 80 watts of power consumption for each four square feet of cross sectional plenum area. Power supply shall be 120 VAC, 60 Hz. Power supply shall be matched to the lamp and designed to maximize photon production, radiance and reliability. Electronic power supply shall be UL listed for application in airstreams between 55 and 135°. There shall be a single source power connection wired with the VFD through a disconnect switch.
7. Portal: The UV lamp plenum area shall be equipped with a portal for viewing the lamp assembly. Portal shall be constructed to allow viewing without the possibility of exceeding the Minimal Erythermal Dose.
8. Testing and Safety Listing: UV fixtures shall have been tested and listed as UL/C-UL under Category Code ABQK (accessories, air duct mounted), UL Standards 153, 1598 and 1995 respectively. No exceptions. Manufacturer of UVC components shall be ISO 9001 certified.

2.07 VARIABLE FREQUENCY DRIVE

A. General: Refer to Section 23 0520. Variable Frequency Drives shall be furnished and installed by Air Handling Unit manufacturer and shall be factory wired and installed.

2.08 FACTORY TESTING

A. Standard Factory Tests
1. The fans shall be factory run tested to ensure structural integrity and proper RPM. Provide copy of the test report as part of equipment submittal.
2. All electrical circuits shall be tested to ensure correct operation before shipment of unit.
3. Units shall pass quality control and be thoroughly cleaned prior to shipment.

B. Factory Sound Testing: The equipment manufacturer shall furnish calculations showing the estimated sound power levels at the supply and, return connections, as well as unit casing radiation for each air conditioning unit. Calculations shall be based on fan sound power levels which were determined in accordance with AMCA Standard 300 and 301. Provide copy of the test report as part of equipment submittal. Sound power levels shall be determined for each octave band and shall not exceed the following:

Sound Data at the Openings of Air Handler Units

Frequency	63	125	250	500	1000	2000	4000	8000	LwA
AHU-1									
Supply Outlet Opening Top	75	73	78	85	82	77	79	72	87
Return Outlet Opening	89	89	91	99	90	90	90	86	99
AHU-1									
Supply Outlet Opening Side	69	68	71	82	81	78	77	70	86
AHU-2									
Supply Outlet Opening Side	71	73	87	80	78	75	76	65	84
Return Outlet Opening Side	73	82	82	70	71	72	69	61	79

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF AIR HANDLING UNITS

A. General: Install air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

B. Coordination: Coordinate with other work, including ductwork, floor construction, roof-decking, and piping, as necessary to interface installation of air handling units with other work.

C. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.

D. Piping Connections: Refer to Division 15 HVAC sections. Provide piping, valves, accessories, gages, supports, and flexible connectors as indicated.

E. Duct Connections: Refer to Division 15 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated.

F. Grounding: Provide positive equipment ground for air handling unit components.

3.03 FIELD QUALITY CONTROL

A. Testing: Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements, field correct malfunctioning units, then retest to demonstrate compliance.

3.04 EXTRA STOCK

A. Furnish in original packaging from manufacturer and label each spare part to match the air handler unit tag the following spare parts for each air handler unit:
   1. One complete set of filters for each air handler.
   2. Obtain receipt from Owner that filters have been received by owner.

END OF SECTION 23 7513

SECTION 23 8126

VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Split DX cooling only and heat pump system with indoor split DX fan coil and outdoor cooling/condensing unit.

B. The cooling only variable refrigerant flow system is a two-pipe system consisting of a single outdoor units, 6 indoor units of high wall type and capacities as noted on the VRF schedule, individual indoor unit controls with on/off temperature settings, all connected by fully insulated refrigerant lines utilizing factory supplied, fully insulated, branching kits. Indoor units are connected to condensate piping and shall be terminated to the nearest drain point.

C. The system shall be fully capable of providing cooling only as requested by the individual indoor zones that can consist of single or multiple indoor units.

D. The total connected indoor unit capacity shall range between 80 and 125% of the outdoor unit capacity.

E. Indoor, high wall mounted, direct-expansion indoor units are matched with heat pump or heat recovery VRF (variable refrigerant flow) outdoor unit.

1.02 RELATED SECTIONS

A. Related sections include but are not limited to the following:

1. Division 23

    a. Section Basic HVAC Requirements.
    b. Section Electrical Requirements for HVAC Equipment.
    c. Section Building Automation System required in conjunction with split cooling system.
    d. Section Testing, Adjusting and Balancing.
    e. Section Power and Gravity Ventilators.

2. Division 26

    a. Section Electrical Connections for Equipment.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions.

B. Shop Drawings:

1. Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop cooling/condensing and DX fan coil units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
2. Submit shop drawings detailing the mounting, securing, and flashing of the outdoor unit to redwood sleepers and sleepers to the roof structure. Indicate coordinating requirements with roof membrane system.

C. Operation and Maintenance Data: Submit maintenance data and parts list for each split cooling system, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual in accordance with requirements of Division 01.

1.04 QUALITY ASSURANCE

A. Codes and Standards:

1. Refrigerating system construction of split cooling system shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
2. Seasonal Energy Efficiency Ratio (SEER) of split cooling system shall be equal to or greater than prescribed by Title 24 California Administrative Code "Building Energy Efficiency Standards".
3. Split cooling system shall be designed, manufactured, and tested in accordance with UL requirements.
4. Units shall be listed by ETL (Engineering Testing Laboratory) and be evaluated in accordance with UL standard 1995, 4th. Edition.
5. Units shall be listed in the AHRI directory.
6. All units shall meet the Federal minimum efficiency standards and be tested per AHRI 1230 Standard.

1.05 DELIVERY, STORAGE AND HANDLING

A. Handle split cooling system and components carefully to prevent damage. Replace damaged rooftop units or components with new.

B. Store split cooling system and components in clean dry place, off the ground, and protect from weather, water, and physical damage.

C. Rig outdoor units to comply with manufacturer's rigging and installation instructions for unloading outdoor units, and moving them to final location.

D. Units shall be shipped in one piece and shall be stored and handled per unit manufacturer's recommendations.

E. Units shall be supplied with a base rail that provides openings for moving the unit by fork truck or rigging the unit by crane.

1.06 SCHEDULING AND SEQUENCING

A. Coordinate installation of outdoor unit redwood sleepers with roof structure.

B. Coordinate roof-opening locations for mechanical and electrical connections.

1.07 SPECIAL WARRANTY

A. Provide manufacturer's standard warranty.

B. Warranty on Compressor: Provide written warranty, agreeing to replace/repair, including all parts and labor within warranty period, compressors with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform a required provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period.

C. Warranty period shall be for a period of one year from the agreed start of the District's beneficial use.

D. Extended warranty period. Provide written warranty signed by manufacturer, agreeing to replace components parts only, for an additional four (4) years for all hermetically sealed compressors.

1.08 MAINTENANCE

A. Extra Materials: Furnish to District, with receipt, the following spare parts for each split cooling system:

1. One set new filters for each unit set.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide products of one of the following manufacturers:

1. Toshiba Carrier Corp.
2. Mitsubishi
3. Trane

2.02 SPLIT COOLING SYSTEM (GENERAL)

A. Outdoor Condensing Unit - Factory-assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the multiple inverter-driven twin rotary compressors.

1. The maximum sound pressure rating for a single module shall not exceed 62 dBA sound pressure in cooling and 63 dBA in heating and for twinned systems the sound pressure numbers should not exceed 65 dBA and 66 dBA. Sound pressure ratings are measured at a distance of 3 ft out and 4 ½ ft up from the side of the outdoor unit.
2. The outdoor unit shall include an oversized accumulator and a liquid tank for proper heating performance while allowing the indoor unit PMV (pulse modulating valve) metering device to shut off completely when a zone is satisfied.
3. The outdoor unit shall be protected by a high-pressure switch, high-pressure sensor, low-pressure sensor, fusible plug, PC board, and inverter overload protector.

4. The outdoor unit shall be capable of operating in cooling mode down to 23 F ambient air temperature.
5. The outdoor unit shall include a total oil management system that balances oil between compressors within a module, replenishes compressor oil to the compressors in a module from the oil separator if required, and allows oil and refrigerant to move between twinned units if required, even if one of the units is not running. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with coil, fan driven by DC inverter motor, PMV (pulse modulating valve), piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

B. Unit Cabinet:

1. Outdoor unit cabinet shall be constructed of pre-coated steel, finished on both inside and outside.
2. Outdoor Unit access panels shall be removable with minimal screws and shall provide full access to the compressors, fan, and control components.
3. Compressors shall be isolated in a compartment and have an acoustic wrap to assure quiet operation.
4. The outdoor unit control panel shall include a sliding window to access adjustable controls and an LED display for setup and diagnostics.
5. Outdoor unit cabinet shall be capable of withstanding 500-hour salt spray test per Federal Test Standard No. 141 (method 6061).
6. Indoor unit cabinet discharge and inlet grilles shall be attractively styled, high-impact nonmetallic material.

C. Fans:

1. Outdoor fan shall discharge air vertically and be driven by a DC inverter variable speed motor with 64 steps that is capable of running down to 60 rpm.
2. Outdoor fan motor shall be totally-enclosed with permanently-lubricated bearings.
3. Outdoor unit motor shall be protected by internal thermal overload protection.
4. Outdoor unit fan blade shall be non-metallic and shall be statically and dynamically balanced.
5. Outdoor fan shall be protected by a raised non metallic protective grille.
6. Indoor unit fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be standard.
7. Indoor unit vertical air sweep operation shall be user selectable using the remote control and the horizontal air direction may be set manually.

D. Outdoor Unit Compressors:

1. Each outdoor unit module shall be equipped with two or three inverter-driven twin rotary compressors with full range control to an accuracy of ±0.1 Hz.
2. Compressor shall be totally enclosed in the machine compartment.
3. Compressors shall be equipped with factory mounted crankcase heaters.
4. Internal overloads shall protect the compressor from over-temperature operation.
5. Motor shall be suitable for operation in an R-410A refrigerant atmosphere.
6. Compressor assembly shall be installed on rubber vibration isolators.

7. To maximize compressor reliability, multiple compressors within a module shall be started and operated in variable patterns to ensure equal run time on all compressors.
8. To ensure maximum efficiency throughout the system operation range, no compressor is required to run at maximum speed under any condition.

E. Coils:

1. Outdoor unit coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
2. The outdoor unit coil configuration shall be 4-sided and fully separated from the machine compartment for more effective heat transfer and sound isolation.
3. The outdoor unit coil fins shall have a factory-applied corrosion resistant blue-fin finish.
4. The indoor unit coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wetability. A drip pan under the coil shall have a factory-installed drain connection (on both ends) for hose attachment to remove condensate.

F. Controls and Safeties:

1. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

    a. Compressor speed to match the refrigerant flow and capacity with the system requirements.
    b. Outdoor fan motor speed for higher efficiency and lower sound.
    c. Oil control for improved system reliability and comfort
    d. Pulse modulating valve control for precise control of the refrigerant distribution and accurate capacity management to avoid starving any units.
    e. Control of compressor staging to maximize reliability and minimum run time on all compressors.
    f. Module control of compressor operation, compressor speed, and outdoor heat exchanger surface to maximize efficiency and sound level and reliability across the entire operating range of the system.
    g. Control of the outdoor heat exchanger surface (main vs sub heat exchangers) for maximum efficiency and comfort.

2. Safeties: The following safety devices shall be part of the condensing unit:

    a. High-pressure switch
    b. Fuses
    c. Crankcase heater
    d. Fusible plug
    e. Over-current relay for the compressor
    f. Thermal protectors for compressor and fan motor
    g. Compressor time delay
    h. Oil recovery system
    i. Oil level sensor
    j. Over-current sensor
    k. Compressor suction and discharge temperature sensor
    l. l. Compressor suction and discharge pressure sensor

G. Controls and Management:

1. Controls:

    a. The system shall be microprocessor-controlled to maintain precise room temperature and minimum power consumption. The controls system shall employ a genetic algorithm for temperature control. Wired remote controller shall communicate over two-core shielded wire up to 1640 ft. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air (TA) can be sensed at the unit, at the remote controller or through a remote sensor. The local controller shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.

H. Management Systems:

1. The system shall be able to be controlled by BACnet* protocols either directly or through an external gateway. Refer to control drawings and specifications for control system requirements for a successful connection to the building BACnet system. BACnet shall be able to control:

    a. ON / OFF
    b. Operation mode
    c. Fan-speed
    d. Louver
    e. Set-temperature
    f. Permit / prohibit local operation

2. BACnet shall be able to monitor:

    a. ON / OFF
    b. Operation mode
    c. Fan-speed
    d. Louver
    e. Set-temperature
    f. Permit / prohibit local operation
    g. Room temperature
    h. Error status
    i. Error code

3. The unit shall have the following functions as a minimum:

    a. Selectable automatic restart. After power failure the system will restart at the same operating conditions as before the failure.
    b. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
    c. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
    d. Automatic air sweep control to provide multiple operating modes of the air sweep louvers.
    e. Dehumidification mode shall provide increased latent removal through total system modulation.
    f. Fan-only operation to provide room air circulation when no cooling is required.

g. Fan-speed control shall be user-selectable: high, medium, low, or microprocessor determined (Auto) based on the differential between the room temperature and the set point during all modes of operations.
h. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
i. Cold blow prevention in heating.
j. Adjustable compensation for air stratification in heating.

I. Electrical Requirements:

1. All sizes shall utilize 208/230-3-60 (V-Ph-Hz) field power supply.
2. Twinned systems shall have separate field power supply to each module.
3. Two-core, standard, shielded low voltage cable shall be required for communication between outdoor and indoor unit.
4. All power and control wiring must be installed per NEC and all local electrical codes.

J. Refrigerant Piping and Line Lengths:

1. Piping connections shall be from the front or the bottom of the unit. The unit shall be capable of operating with maximum connected refrigerant line lengths of 985 ft (actual).
2. The outdoor unit shall have the ability to operate with a maximum height of 230 ft between the outdoor and the lowest indoor unit.
3. The maximum distance between the outdoor unit and the furthest fan coil shall not exceed 590 ft actual or 720 ft equivalent. No line size changes or oil traps shall be required.
4. The system shall be capable of operating when the height difference between the upper and the lower fan coil is 130 ft.

K. Auxiliary Refrigerant Components:

1. All field-supplied copper tubing connecting the outdoor unit to the indoor unit shall use factory-supplied branching kits consisting of either Y joints or headers to ensure even refrigerant flow.
2. To ensure piping flexibility, the system shall allow having Y joints or headers downstream of another header.

L. Motors:

1. Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be inverter controlled variable speed.

M. Filters:

1. Unit shall have factory-supplied resin net (cleanable) type filters. The return air filter material shall have the following characteristics:

a. Odorless
b. Temperature resistant to 185 F
c. Humidity resistant up to 95% RH

N. Special Features (Accessories):

1. Condensate pump - Refer to mechanical drawings for condensate pump requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which split cooling system is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

A. General: Install split cooling system in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Install and secure redwood sleepers to roof structure, in accordance with National Roofing Contractors Association (NRCA) installation recommendations and shop drawings.

C. Electrical Connections: Refer to Division 26 Electrical Connections for Equipment for final connections to equipment and installation of loose-shipped electrical components.

3.03 DEMONSTRATION

A. Provide the services of a qualified service representative to start-up split cooling system in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

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