CONTRACT DOCUMENTS
FOR
LOS MEDANOS COLLEGE
2700 E. Leland Rd. Pittsburg, CA 94565

L-630 New Brentwood Center
AT
1351 Pioneer Square
Brentwood, California, 94542

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

Consist of the following:

DSA File #7-C1
DSA Application # 01-116287

ADDENDUM #2
Drawings & Specification

Architect: RATCLIFF
5856 Doyle Street Emeryville, CA 94608

April 26, 2018
CONTRA COSTA COMMUNITY COLLEGE DISTRICT

L-630 New Brentwood Center
Los Medanos College

ADDENDUM #2 Date: 4/26/18

NOTICE TO ALL PRE-QUALIFIED CONTRACTORS ONLY

You are hereby notified of the following changes, clarifications and/or modifications to the original Contract Documents, Project Manual, Drawings, Specifications and/or previous Addenda. This Addendum shall supersede the original Contract Documents and previous Addenda wherein it contradicts the same, and shall take precedence over anything to the contrary therein. All other conditions remain unchanged.

This Addendum forms a part of the Contract Documents and modifies the original Contract Documents dated April 3, 2018. Acknowledge receipt of this Addendum in space provided on the Bid Proposal Form. Failure to acknowledge may subject Bidder to disqualification.

A. Pre-Bid Questions (RFIs) and Responses
Pre-Bid Requests for Information (RFIs), along with Responses, are included as an attachment to this Addendum.

PLEASE NOTE: Last Day to Issue Addendum: May 3, 2018
Bids Due No Later Than, Date / Time: May 10, 2018 (prior to 2:00PM)

B. ADDITIONS, DELETIONS, REVISIONS, REPLACE SPECIFICATIONS, DIV 0 & 1

1. REVISION: Table of Contents
Include added section.

2. REVISION: Section 00100 Notice Inviting Bids
Revised bid RFI submittal date, last Addendum issue date and Bid Opening date.

3. REPLACE: Section 00300 Bid Proposal Form
(Section 00300 is deleted in its entirety and is being replaced with the attached Section 00300).

4. REPLACE: Section 01030 Alternates
(Section 01030 is deleted in its entirety and is being replaced with the attached Section 01030).
C. ADDITIONS, DELETIONS, REVISIONS, REPLACE TECHNICAL SPECIFICATIONS:

1. REPLACE: Section 12 24 13 – Window Shades
   Replace Section 12 24 13 – Window Shades in its entirety and replace with attached Section 12 24 13, revised as indicated.

2. REPLACE: Section 22 10 00 – Plumbing Piping and Valves
   Replace Section 22 10 00 – Plumbing Piping and Valves in its entirety and replace with attached Section 22 10 00, revising Article 3.3(A) to make Lab Waste piping Schedule 80, and adding Article 3.3(B) to indicate piping for lab waste vents.

3. REPLACE: Section 23 05 00 – Common Work Results for Mechanical
   Replace Section 23 05 00 – Common Work Results for Mechanical in its entirety and replace with attached Section 23 05 00.

4. REPLACE: Section 23 05 29 – Hangers, Supports and Seismic Restraint for HVAC Piping and Equipment
   Replace Section 23 05 29 – Hangers, Supports and Seismic Restraint for HVAC Piping and Equipment in its entirety and replace with attached Section 23 05 29.

5. REPLACE: Section 23 07 00 – HVAC Insulation
   Replace Section 23 07 00 – HVAC Insulation in its entirety and replace with attached Section 23 07 00.

6. REPLACE: Section 23 09 01 – Laboratory Controls System
   Replace Section 23 09 01 – Laboratory Controls System in its entirety and replace with attached Section 23 09 01.

7. REPLACE: Section 23 21 13 – Hydronic Piping and Valves
   Replace Section 23 21 13 – Hydronic Piping and Valves in its entirety and replace with attached Section 23 21 13.

8. REPLACE: Section 23 30 00 – HVAC Air Distribution
   Replace Section 23 30 00 – HVAC Air Distribution in its entirety and replace with attached Section 23 30 00.

9. REPLACE: Section 23 34 00 – HVAC Fans
   Replace Section 23 34 00 – HVAC Fans in its entirety and replace with attached Section 23 34 00.

10. REPLACE: Section 23 73 00 – Air Handling Units
    Replace Section 23 73 00 – Air Handling Units in its entirety and replace with attached Section 23 73 00.

11. REPLACE: Section 23 73 05 – Split Air Conditioning Unit System
    Replace Section 23 73 05 – Split Air Conditioning Unit System in its entirety and replace with attached Section 23 73 05 – VRV System.
12. ADDITION: Section 32 31 13 – Chain Link Fences and Gates
   Add Section 32 31 13 – Chain Link Fences and Gates in its entirety related to Deductive Alternates 2.B.3 and 2.B.4.

13. REPLACE: Section 32 33 00 – Site Furnishings
   Replace Section 32 33 00 – Site Furnishings in its entirety and replace with attached Section 32 33 00, adding Article 1.4(A)(3) regarding shop drawings for custom site furnishings.

14. REPLACE: Section 32 80 00 – Irrigation
   Replace Section 32 80 00 – Irrigation in its entirety and replace with attached Section 32 80 00, revising Article 2.7(D) regarding master valve type and sizing.

D. REVISION TO DRAWINGS SHEETS:
   All drawing modifications are indicated on the drawings with a cloud graphic and a Delta 2.

   1. C-400 – HORIZONTAL LAYOUT
      Refer to civil sketch CSK-001 for drop off curb ramp layout for Deductive Alternate 2.B.2 as described in Specification Section 01030.

   2. C-410 – STRIPING AND SIGNAGE PLAN
      Additional street signage required by City of Brentwood.

   3. C-411 – STRIPING AND SIGNAGE DETAILS
      Revised Roadside Sign Table; add “SPEED LIMIT 25” sign type, Sign Code: R2-1; add “NO LEFT TURN” sign type, Sign Code: R3-2; add “2 HOUR PARKING” sign type, Sign Code: R32(CA); add “BUMP” sign type, Sign Code: W8-1 MOD; add “15 MPH” sign type, Sign Code: W13-1(15).

   4. C-510 – GRADING PLAN DETAILS
      Plan Detail 3 – Passenger Drop Off Grading Detail: Revise spot elevations at transition between speed table and sidewalk.

   5. C-600 – UTILITY PLAN
      Revisions of select underground utility descriptions in plan; addition of Note #8 regarding cathodic protection requirements.

   6. C-700 – CONSTRUCTION DETAILS
      Detail 2, clarification of deepened curb depth and reinforcement; Detail 4, revision of reinforcement from “#3 Bar” to “#4 Bar”.

   7. C-701 – CONSTRUCTION DETAILS
      Detail 10, addition of City of Brentwood Standard Plan Sheets W-8 and W8a describing backflow prevention device installation and pre-approved device assemblies; Detail 12, delete Trench Drain detail and replace with City of Brentwood Standard Plan Sheet ST-7a Residential Driveway with Monolithic Sidewalk detail.

   8. C-702 – CONSTRUCTION DETAILS
      Detail 13, eliminate 12” band truncated domes in speed table surface.
9. **L-100 – LANDSCAPE REFERENCE PLAN**  
Correction of Deductive Alternate 2.B.1 (“Replace Asphalt Parking Lot”) callout note; add locations and extent of Deductive Alternates 2.B.5a and 2.B.5b (“Reduce Perimeter Hydroseed and Associated Temporary Irrigation”).

10. **L-101 – CONSTRUCTION PLAN A (MAIN BUILDINGS)**  
Revise Furnishing Schedule to clarify arm rests and backrest configurations of Linear Benches Types T1 – T5.

11. **L-202 – CONSTRUCTION DETAILS**  
Revise Linear Bench Details 1 and 2.

12. **AS-102 – TRASH ENCLOSURE DETAILS**  
Details C4 and D3: Revise corner closure trim material description from “ALUM” to “STL”. Trash Enclosure Plan C1: Clarified extent of grade beam matching level of paving and enclosure post callout.

13. **AS-105 – TRANSFORMER ENCLOSURE DETAILS**  
Detail A3: Revise perforated corrugated steel panels material description from “18 GA., MORIN BR7-35, .040 GA, 1/8” DIAMETER HOLES X 1/4” SPACING, 23% OPEN AREA” to “18 GA., MORIN BR7-35, 1/8” DIAMETER HOLES X 7/32” SPACING, 30% OPEN AREA”.

Refer to attached sketch ASK-001 for revised Wall Keynotes Type W3 description, changing all references of “ALUMINUM” to “STEEL”.

Refer to attached sketch ASK-001 for revised Wall Keynotes Type W3 description, changing all references of “ALUMINUM” to “STEEL”.

Clarification of rooms with ACT-2 ceiling type; addition of Wireless Daylight Sensor (WDS) symbol and location.

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Clarification of rooms with ACT-2 ceiling type; addition of Wireless Daylight Sensor (WDS) symbol and locations.

Refer to attached sketch ASK-001 for revised Wall Keynotes Type W3 description, changing all references of “ALUMINUM” to “STEEL”.
   Refer to attached sketch ASK-001 for revised Wall Keynotes Type W3 description, changing all references of “ALUMINUM” to “STEEL”.

22. A-610 – FINISH LEGEND
   Clarification of ceiling types ACT-1 and ACT-2.

23. S-133 – PARTIAL ROOF FRAMING PLAN – AREA C
   Correction of keynote callout between Grid Lines B and C, and Grid Lines 14.4 and 14.8.

24. S-901 – EXTERIOR LIGHT GAGE DETAILS
   Correction of keynote callout, Detail 2 (Special Condition); clarification of HSS beam detail callout at slip joint, Detail 2 (At Dormers).

25. S-902 – EXTERIOR LIGHT GAGE DETAILS
   Add new Detail 5 – Top Anchor detail.

26. M-111 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 1
   Revised SA CFM in Counselor Office 121.

27. M-112 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 2
   Deleted note “3/4” RG 3/8” RL UP TO CU-1”.

28. M-113 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 3
   Modified CM-2-14 cooling coil size; revised SA CFM in Autoclave 223; revised SA CFM in Chem. Prep. 213.

29. M-114 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 4
   Renumber the EAV tag; number “TYP. #” of the High Volume Low Velocity Diffuser has been changed.

30. M-116 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 6
   Revised SAV 3-17 unit size and the inlet duct size.

31. M-117 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 7
   Revised branch ductwork size, diffuser neck size, and DFMs for SAV 4-4 in Math Lab 410.

32. M-118 – PARTIAL LEVEL 1 MECHANICAL PLAN – AREA 8
   Added new T-stat to IDF 04-404; revised SA CFM in Lobby 100.

33. MP-113 – PARTIAL LEVEL 1 MECHANICAL PIPING PLAN – AREA 3
   Modified CM-2-14 cooling coil size; revised SA CFM in Autoclave 223; revised SA CFM in Chem. Prep. 213.

34. MP-114 – PARTIAL LEVEL 1 MECHANICAL PIPING PLAN – AREA 4
   Revised pipe size of the chilled water supply/return.
35. **MP-116 – PARTIAL LEVEL 1 MECHANICAL PIPING PLAN – AREA 6**
Revised SAV 3-17 unit size and the inlet duct size.

36. **M-400 – ENLARGE MECHANICAL PLAN**
Changed section scale; modified boiler tag; changed bypass pipe size from 3”Ø to 1-2”Ø.

37. **M-506 - DETAILS**
Detail 2, deleted not “PLUMBING CONTRACTOR TO PROVIDE UNISTRUT SUPPORT FOR ALL TRADES”.

38. **M-600 – CHILLED WATER SYSTEM PIPING DIAGRAM**
Revised pipe size of the chilled water supply/return.

39. **M-702 - SCHEDULES**
Modified the following area in schedule. “Cooling Max”, “(no.) Inlet Size”, “Notes”, “CFM (Min.Max.)”, “Damper Size (in)”, and “Duct Size”.

40. **M-805 – CONTROL DIAGRAMS**
Added new makeup water pressure sensor.

41. **M-806 – CONTROL DIAGRAM**
Added new makeup water pressure sensor.

42. **P-113 – PLUMBING LEVEL 1 PARTIAL PLAN 3**
Changed NG pipe line in Biology Lab 225 from ¾” to 1-1/2”; connected underground NG line to line in ceiling; changed sheet note to clarify location of NG drop to trench.

43. **P-114 – PLUMBING LEVEL 1 PARTIAL PLAN 4**
Changed NG pipe line in Biology Lab 225 from ¾” to 1-1/2”; connected underground NG line to line in ceiling; changed sheet note to clarify location of NG drop to trench.

44. **P-500 – PLUMBING DETAILS**
Detail 11, removed mention of stainless steel clamps; Detail 12, removed unnecessary text.

45. **P-601 – PLUMBING FIXTURE AND EQUIPMENT SCHEDULE**
Modified “Gas Shut-Off Valve Box Schedule” to include valve box dimensions; added information to valve box specifications to refer to specific pipe sizes; modified “Pipe Schedule” to show separate Labe Waste (LW) and Lab Waste Vent (LWV) specifications – LWV now requires Schedule 40 CPVC and ASTM requirements for LW changed to F2618 to conform to Schedule 80 CPVC requirement.

46. **P-605 – PLUMBING FIXTURE AND EQUIPMENT SCHEDULE**
Updated diagram name to “NATURAL GAS DIAGRAM” and changed scale from 12”=1'-0” to NTS; updated diagram to include additional gas shut-off valve GSV-05; updated all GSV tags to match floor plans.

47. **SG-100 – SIGN TYPE LIST AND SIGN COUNTS**
Revise sign type ED quantity.
48. SG-101 – SIGNAGE LOCATION PLAN - SITE
Add sign type S.ED.8.

49. SG-104 – MESSAGE SCHEDULE SITE SIGNAGE
Revise sign type S.ED.2 message schedule; add sign type S.ED.8 message schedule.

50. SG-201 – SITE SIGNAGE
Detail 3 – Detail @ Pedestrian Direction / Sign Type ED: Revise sign type S.ED.2; add sign type S.ED.8.

If you have any questions regarding this Addendum, please contact:

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All other terms and conditions of BID are to remain the same.

Mark McFarlin
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END OF ADDENDUM #2
1. **Question:** RFI 001: 2/C-700 There is only a callout for #5, There are no dimensions, rebar spacing, etc. We used #5@18” ew with a wall of 3’-6” high. Please clarify
   **Response:** Deepened curb on Detail 2/C-700 shall be 3'-6" high with #5 rebar @ 18" each way.

2. **Question:** RFI 002: 4/C-700 This vehicular pavement #3’s at 12”, On L-201 Sections 1,2,3,4, and 5 calls for #4’s at 12” ew. We used #4’s @12” ew. Please clarify
   **Response:** Revise rebar size for vehicular concrete flatwork on Detail 4/C-700 to "#4 BAR @ 12" O.C. EACHWAY, MID-DEPTH OF SLAB".

3. **Question:** RFI 003: AS-101, 102 Confirm Trash enclosure has only 3 piers?
   **Response:** Per C1/AS-102 plan, trash enclosure has 20 (verify) HSS posts. Each post requires a 24”-diameter foundation (“pier”) as detailed same sheet.

4. **Question:** RFI 004: Sheet A-524 Section A2 shows a curb, there are no indications of a curb or what to put in it on the Structurals. Also, what is the extent of this curb?
   **Response:** Detail A2/A-524 is referenced from Detail Section B3/A-318. Rooftop mechanical wells in Area B (refer to Sheet A-318) and Area D (refer to Sheet A-320) have similar curbs. Typical curbs on deck with concrete fill conditions are shown on Detail 18/S-705 and 19/S-706.

5. **Question:** RFI 005: Sheet S-501 Typical Raised Floor, where does this occur?
   **Response:** Per consulting engineer, Detail 3/S-501 does not apply this project. Note, Detail 4/S-501 also does not apply this project.

6. **Question:** RFI 006: The specifications section 33 40 00 – Storm Drainage Utilities, Section 2.1 – Products, states: for pipe sizes 4” – 15” the pipe shall be SDR 35. However, there is about 1,200 LF of 18” Storm Drain. Please confirm this pipe should be SDR 35 as well.
   **Response:** Per consulting engineer (BKF Engineers), 18” storm drain pipe is SDR 35.

7. **Question:** RFI 007: The deductive alternate # 5 is to reduce hydroseed & temp irrigation. Please provide a drawing indicating the area and the location of deductive alternate # 5. There is a reference made on the irrigation legend in drawings L-601-L-603 for a Temporary Irrigation zone, but there is not a detail or symbol for the description.
   **Response:** Clarification of location(s)/area(s) of Deductive Alternate #5 to be provided via forthcoming addenda. Refer to legend on Sheets L-601, L-602, and L-603 for temporary irrigation zone symbols and device descriptions (screen capture shown below).
8. **Question:** RFI 008: ACT-1 Ceiling tile type on Finish Schedule A-610 is not listed. Please give product design and product number to use on this project.

   **Response:** ACT-1 is Armstrong Ultima #1914 24"x48" ceiling tile.

9. **Question:** RFI 009: ACT-1 on the RCP's looks to be ACT-2 per ceiling legend, but ACT-2 is not listed. Will there be an ACT-2 added to finish schedule or do we use ACT-1 and use a 6" slot tile to create lay-out shown on RCP's?

   **Response:** Ceiling plan tags to be clarified in upcoming addenda where ceiling type ACT-2, per Ceiling Legend, occur. ACT-2 is Armstrong Ultima Techzone #1915, 24" x 48" with 6" slots ceiling tile system, to be clarified in upcoming addenda.

10. **Question:** RFI 010: Is ACT-3 a lay-in or regular ceiling tile. Please give product number to use on this project.

   **Response:** ACT-3 is Armstrong Ultima Health Zone ceiling tile as indicated on Finish Legend, Sheet A-610. Use product #1936 for use with specified 9/16" Suprafine XL Grid system.

11. **Question:** RFI 011: The contract drawing L-401, reference the civil drawings C-400 & C-710 for the gutter & striping layout. However, C-400 provides a circular reference back to the Landscape drawings for hardscape and drawing C-710 does not exist. Please provide a drawing that indicates the curb types for the project.

   **Response:** See Sheets C-400, C-401, C-402, and Detail 18/C-702 for curb and gutter layout and construction, and sheet C-410 for striping layout

12. **Question:** RFI 012: Is it acceptable to the electricians that plumbing contractors are installing all of the racks required for their conduit per detail #2 on M506?

   **Response:** Per consulting engineer, each trade shall be responsible for their own support and bracings.

13. **Question:** RFI 013: How will I quantify the number of hangers/supports required for the electrical work? Please provide a count on these items

   **Response:** Per consulting engineer, hanger and bracing requirements are specified in specification. It is the contractor’s responsibility to determine the exact hanger and bracing installation requirement per the project’s contract document.

14. **Question:** RFI 014: On sheet M-600 there is a sheet note number 1 which directs you to M-500 for typical chilled water connections, and the details on M500 are all connection details to the structure and or curb mounting requirements, we will need to know if the owner wants the same detail as the reheat coils or if they want another a different detail, please advise.

   **Response:** Per consulting engineer, Note 1 on Sheet M-600 should read as follows:

   SEE DRAWING M-503 FOR TYPICAL COOLING COIL PIPING DETAIL

15. **Question:** RFI 015: The contract drawing L-401, reference the civil drawings C-400 & C-710 for the gutter & striping layout. However, C-400 provides a circular reference back to the Landscape drawings for hardscape and drawing C-710 does not exist. Please provide a drawing that indicates the curb types for the project.

   **Response:** See Sheets C-400, C-401, C-402, and Detail 18/C-702 for curb and gutter layout and construction, and sheet C-410 for striping layout
16. **Question:** RFI 016: Where does 12/ C-701 occur?
   **Response:** Per consulting engineer, Detail 12/C-701 does not occur this project and will be deleted from drawings.

17. **Question:** RFI 017: Is the Audio-Visual Package complete?
   **Response:** AV Contractor is responsible for all AV infrastructure, cabling and devices with the exception of those devices identified as Owner-Furnished and Owner-Installed. For items identified as Owner-furnished and Contractor-installed, Contractor shall coordinate with District Representative to integrate Owner-furnished items into AV system.

18. **Question:** RFI 018: Is ALS System IR or FM?
   **Response:** Specification Section 27 41 16, Article 2.3 provides FM system and Basis of Design for Assistive Listening.

19. **Question:** RFI 019: Define Projection Screen, i.e. Finish, Size, and Manufacturer.
   **Response:** Projection is onto 59.5” x 95.25” IdeaScreen Projection Board.

20. **Question:** RFI 020: Define Projector for TA-702.
    **Response:** Current District AV Standard document Rev 0.2 dated January 2017 identifies Epson Pro G7200W or G2700WNL as District standard (Owner-furnished, Contractor-Installed) projector for medium and large classrooms.

21. **Question:** RFI 021: Define AVSW per Drawing TA-701 and TA-702.
    **Response:** Refer to specification Section 27 41 16, Article 2.5.

22. **Question:** RFI 022: Define Equipment Racks.
    **Response:** Owner-furnished Lecterns come with racking compartment. For small conference room or spaces without racking lecterns provide Middle Atlantic SR-SR Series or equal.

23. **Question:** RFI 023: Per drawing TA-701 confirm the following items are Owner-Furnished/Owner-Installed (OFOI): Doc Camera, Air Media, Computer, Network Switch.
    **Response:** Air Media will be revised to Contractor-Furnished/Contractor-Installed, all other items listed above are OFOI.

24. **Question:** RFI 024: Per drawing TA-701 confirm projectors are Owner-Furnished/Contractor-Installed (OFCI).
    **Response:** Yes, projectors are OFCI.

25. **Question:** RFI 025: City of Brentwood Detail ST-7a Residential Driveway with Monolithic Sidewalk, referenced on drawing C-400, is not in the contract drawings. Confirm this detail is to be used.
    **Response:** Yes, City of Brentwood Detail ST-7a is the correct detail referenced by the drawings. Detail has been added this addendum.

26. **Question:** RFI 026: Deductive Alternate #1 (Replace Asphalt Parking Lot) indicated to provide 2,160 LF of railroad tie bumpers in lieu of curbs to delineate parking rows. Provide a drawing showing where this will take place, and the size and details of the railroad tie bumpers.
    **Response:** Area of Deductive Alternate #1 is outlined on Sheet L-100. Clarification of alternate, including bumpers in lieu of curbs, is provided this addendum.
27. **Question:** RFI 027: Soil remediation to meet non-expansive fill requirements outlined in the geotechnical report are the Contractor's responsibility (means and methods). Contractor's proposed remediation method(s), which may include the lime treatment option, shall be designed (e.g. type and percentage of lime) by the contractor, and submitted for review/approval during the construction submittal and review process.

**Response:** Soil remediation to meet non-expansive fill requirements outlined in the geotechnical report are the Contractor's responsibility (means and methods). Contractor's proposed remediation method(s), which may include the lime treatment option, shall be designed (e.g. type and percentage of lime) by the contractor, and submitted for review/approval during the construction submittal and review process.

28. **Question:** RFI 028: Submitting Riello Array hot water condensing boiler as an or equal to specified equipment.

**Response:** Per consulting engineer and Owner, the proposed product is NOT accepted as equal to the Basis of Design unit for the following reasons:
- The proposed product has a different design of the basis of design unit. It is unclear at this point what are the potential impacts to other trades, such as structural, electrical, flue, ducted combustion air intake, and controls.
- The boiler is manufactured in Canadian product. It is unclear what level of local support and services is available.
- The boiler is actually a European design. It is unclear if the components are imperial or metric based. For maintenance purpose, imperial is preferred.
- Unknown installation history and base in the US.

29. **Question:** RFI 029: Detail 3/S-501, where does typical raised floor and/or miscellaneous concrete steps occur.

**Response:** Detail 3/S-501 does not apply this project. Note, Detail 4/S-501 also does not apply this project.

30. **Question:** RFI 030: Detail 2/C-700, there is only a callout for #5 and there are no dimensions, rebar spacing, etc. Please provide.

**Response:** Deepened curb on Detail 2/C-700 shall be 3'-6" high with #5 rebar @ 18" each way.

31. **Question:** RFI 031: Detail 4/C-700, vehicular pavement has #3s at 12”; Sheet L-201, Details 1-5 call for #4s at 12” each way.

**Response:** Revise rebar size for vehicular concrete flatwork on Detail 4/C-700 to "#4 BAR @ 12" O.C. EACHWAY, MID-DEPTH OF SLAB".

32. **Question:** RFI 032: Where does Detail 12/C-701 occur?

**Response:** Detail 12/C-701 does not occur this project and will be deleted from drawings.

33. **Question:** RFI 033: Sheets AS-101 and AS-102, please confirm Trash Enclosure has only 3 piers per Elevations A1, A2, and A3 on Sheet AS-102.

**Response:** Per C1/AS-102 plan, trash enclosure has 20 (verify) HSS posts. Each post requires a 24”-diameter foundation ("pier") as detailed same sheet.
34. **Question:** RFI 034: Sheet A-524, Section A2 shows a curb. There are no indications of a curb or what to put in it on the structural drawings. What is the extent of this curb?

**Response:** Detail A2/A-524 is referenced from Detail Section B3/A-318. Rooftop mechanical wells in Area B (refer to Sheet A-318) and Area D (refer to Sheet A-320) have similar curbs. Typical curbs on deck with concrete fill conditions are shown on Detail 18/S-705 and 19/S-706.

35. **Question:** RFI 035: Do the interior aluminum frames need to carry an STC rating, or is it just the door and hardware ok?

**Response:** Refer to specification Section 08 11 16 Aluminum Frames for product requirements. Refer to Openings Schedule Sheet A-600 for STC rating requirements, where indicated.

36. **Question:** RFI 036: Are they going to paint the interior aluminum frames, or do you want it anodized? If anodized, do you want it clear or dark bronze?

**Response:** Refer to specification Section 08 11 16 Aluminum Frames, Article 2.8(A) for frame finish requirements.

37. **Question:** RFI 037: Clarify for deductive alternate #3 and deductive alternate #4, if for the alternate the deletion of the metal panels also includes deleting all the structural steel framing, the roofing, the concrete columns, and the concrete footings. Also, please clarify if the new fence is going to be a standard 6-foot, galvanized fence. Please provide details for the fencing including any gates.

**Response:** Yes, deletion includes entire structure and foundations, replaced with vinyl-coated fencing in same layout, dimensions, heights, and gates as base bid enclosure. Clarification of alternates, including the enclosure alternates, forthcoming in upcoming addendum.

38. **Question:** RFI 038: (Section 122413) Window fabric spec calls out for MechoSystems EcoVeil 1550 Series in 3% openness. EcoVeil 1550 will not cover the windows using the mullions for natural fabric breaks because EcoVeil only comes in 96" wide and Mecho does not recommend railroading. Also EcoVeil currently has an estimated 2.5 month lead time. We recommend using ThermoVeil 1500 Series in 3% openness because it comes in 126" wide and will be able to cover the larger than 96" wide glass. ThermoVeil looks identical and has a 1 month estimated lead time.

**Response:** Use EcoVeil 1550 as specified, ThermoVeil not acceptable; no railroading of shadecloth; windows greater than 96" wide shall have multiple shadecloth panels, with breaks to occur centered on mullions - 2 or more symmetrical panels where necessary to match mullion layout to be determined during shop drawing submittal review process.

39. **Question:** RFI 039: (Section 122413) Are keyed control stations necessary?

**Response:** Keyed control stations are not necessary; revised specification section included this addendum.

40. **Question:** RFI 040: (Section 122413) Are crank-operator overrides necessary?

**Response:** Crank-operated overrides are not necessary; revised specification section included this addendum.

41. **Question:** RFI 041: (Section 122413) What is meant by “Solar Sensor Control,” SolarTrac automation system or Wireless Daylight sensor control?

**Response:** Sun Sensor Control is a wireless daylight sensor control; revised specification section included this addendum.
42. **Question:** RFI 042: (Section 115310) Article 2.2(B)(4) calls for a UL Listing of the complete table assembly. There is no known manufacturer of custom welded table with a UL Label for the entire assembly. Please confirm that UL Listed electrical components only (not entire table) are acceptable.

   **Response:** UL-Listed electrical components only (not entire table) is acceptable provided the electrical components are installed in the field by a licensed electrician in accordance with the Electrical Code.

43. **Question:** RFI 043: Section 116150 makes several references to outlets for the Controlled Environment Rooms but none are shown in the Lab Furnishing or Electrical drawings. Please clarify whether there are outlets in Cold Room 224.

   **Response:** No electrical outlets are required in the Controlled Environment Rooms wall panels this project.

44. **Question:** RFI 044: Reference drawing S-133 at Grid Line 14.8 & B, where does referenced drawing TS-911 per detail callout occur?

   **Response:** Detail callout corrected to 5/S-902.

45. **Question:** RFI 045: GSV gas zone valves on the Riser Diagram and the Flat plans have different dimensions. Please verify if we are to use the sizing as shown on the flat plans or use the sizing shown on the riser diagram?

   **Response:** Diagrams are not to scale - scale under view title is incorrect. Updated GAS SHUT-OFF VALVE BOX SCHEDULE on revised Sheet P-601 included this addendum.

46. **Question:** RFI 046: Section 221000, page 12 lists schedule 40 CPVC lab waste and vent. The pipe schedule on drawing P-601 lists Schedule 80 CPVC DWV pipe and CPVC drainage type fittings, DWV pattern: ASTM F2618 which are schedule 40 fittings. Is this correct or should the pipe be schedule 40 also?

   **Response:** Lab waste piping are Schedule 80 as shown in the original schedule, and the associated ASTM is F439. Lab waste vents will be Schedule 40. Revisions to Sheet P-601 and specification Section 221000 included this addendum.

47. **Question:** RFI 047: Section 224000, page 6, Lab Sinks c. lists Schott Kimax glass traps. The plumbing schedule under LSK-1 lists a CPVC p-trap. Please clarify which p-trap is to be installed?

   **Response:** Lab waste p-traps are all CPVC. Revised specification Section 224000 included this addendum.

48. **Question:** RFI 048: Irrigation legend refers to Civil plans and the civil plans refer to Irrigation plans regarding the backflow. What is the Make, Model, and size?

   **Response:** Enter response here.

49. **Question:** RFI 049: What size is the Griswold 2000 N.C. Master Valve?

   **Response:** Size master valve for specified mainline size indicated on Sheet L-601.

50. **Question:** RFI 050: Scope of work not clear who is responsible for Drainage, Bio=Treatment Soil, Class 11 Aggregate at Rain Garden Area. Clarify.

   **Response:** Subcontractor scope of work and coordination is the responsibility of the General Contractor.
51. **Question:** RFI 051: Is this a “Tier 1” controls submission to the GCs, or will there be another solicitation to mechanicals and their subs from the selected GC?

**Response:** Bids are due from prequalified General Contractors for the complete scope of work, including controls. There will not be a separate bid solicitation by the District.

52. **Question:** RFI 052: Sheet C-600 shows a sewer line running into an existing SSMH (southeast of proposed building); two depths are provided but based on the direction called out it doesn’t look like a depth is given for the proposed new sewer pipe. Is something mislabeled or is that information not provided?

**Response:** Inverts will be clarified on C-600 this addendum.

53. **Question:** RFI 053: Drawing TN-002, R3 calls for conduit from data device stub up to the cable tray. Specification Section 270529, Article 2.4(A) allows the use of above accessible ceiling J hangers. Can data cable be run on J hangers from the device stub up to the cable tray at accessible locations?

**Response:** No, J-hooks are not allowed for data cabling.

54. **Question:** RFI 054: Specification 280528, Article 3.10(B) calls for access control and intrusion detection to be installed entirely in raceway below the ceiling line. Is J hanger support allowed above the accessible ceiling from the device stub up to the cable tray?

**Response:** No, J-hooks are not allowed for security cabling.

55. **Question:** RFI 055: Is J hanger support for the visual surveillance Cat 6 cables allowed between the cable tray and device stub up?

**Response:** No, J-hooks are not allowed for surveillance cabling.

56. **Question:** RFI 056: Details 1, 2 and 3, on Sheet TN-906, shows seismic support for the cable tray. Please confirm that it is acceptable to have seismic support designed per specification Section 260529 Articles 1.2(A)(1) and 1.2(A)(6)(a and c).

**Response:** No, follow DSA-approved details on Sheet TN-906.

57. **Question:** RFI 057: Detail 9/E-701, under deck pipe support detail is an expensive support at 6’ on center. Specification 26 05 02 2.6 D calls for a ¼” threaded rod support, 26 05 02 3.3 C calls for the use of mineralac clamps at 10’ on center. Please confirm that the use of ¼” rod with a mineralac clamps spaced at 10’ intervals is acceptable.

**Response:** For single conduits 1-1/2” and smaller, 1/4" threaded rod support and mineralac clamps at 10'-0" on center is acceptable. Attachment to metal desk shall be per Detail 9/E-701.

58. **Question:** RFI 058: Detail 4/E-701 shows a mounting support rack. Please confirm that mounting disconnects on the equipment that it controls is acceptable where space is available or on local wall space.

**Response:** Mounting disconnects on equipment not acceptable. Mounting on available wall space is acceptable provided that Code clearances are maintained and disconnect is in sight of equipment.
59. **Question:** RFI 059: Specification Section 250502, 3.3(D) calls for only 12KV service conduits to be concrete encased. Trench details on TN-908 shows cement encasement of underground conduit. Is this required? Does this pertain to communication conduit only?

**Response:** 12 KV service conduits shall be concrete encased. Telecom conduits shall be concrete encased.

60. **Question:** RFI 060: Specification Section 260529, 2.2(A)(2), are supports required from the 1st floor slab to the under slab conduits? These are supported by the compacted earth under the fill.

**Response:** No, supports to floor slab are not required for under slab conduits as they are below grade.

61. **Question:** RFI 061: VAV Air Terminal Schedule Drawing M-702 states Air Valve EAV 2-14 as an 8" Unit Size, but Drawing M-113 states the Air Valve (by Column Lines 2 & 2.6 and F & G) is a 6" Unit Size. Please clarify the Unit size.

**Response:** Air Valve EAV-2-14 size is 6”.

62. **Question:** RFI 062: VAV Air Terminal Schedule Drawing M-702 states SAV 2-14 has a 20"x12" Heating Coil, and CM 2-14 has a 20"x12" Cooling Coil. But Drawing M-113 states CM 2-14 (by Column Lines 2.6 & 3 and E & F) has 12"x9" Coil Sizes. Please clarify the Coil size.

**Response:** Coil size of CM 2-14 is 20"x12".

63. **Question:** RFI 063: VAV Air Terminal Schedule Drawing M-702 has SAV 2-1 with Note #2 that is "based on CRC Fast-Acting Model" Air Valve. But Drawing M-113 depicts SAV 2-1 (by Column Lines 1.4 & 2 and B & D) as an Air Terminal Unit. Please clarify the type of Unit.

**Response:** Note for SAV 2-1 on M-702 will only apply for Note #1.

64. **Question:** RFI 064: VAV Air Terminal Schedule Drawing M-702 states EAV 2-32 as a 10" Unit Size. But Drawing M-114 states EAV 2-32 (by Column Lines 4.2 & 5 and B & D.3) as a 6" Unit Size. Please clarify the Unit size.

**Response:** Air Valve EAV 2-32 size is 6”

65. **Question:** RFI 065: Drawing M-114 depicts two (2) EAV 2-34: One is by Column Lines 4.2 & 5 and B & D, and the other by Column Lines 2.9 & 3 and F & G. Confirm the former one should be EAV 2-38, as it matches the missing Unit in the VAV Air Terminal Schedule Drawing M-702 that services Room #208. Please clarify.

**Response:** One is by Column Lines 4.2/5 and B/D needs to be renumbered to EAV 2-38.

66. **Question:** RFI 066: VAV Air Terminal Schedule Drawing M-702 states Terminal Unit SAV 3-16 as a 14" Unit Size, but Drawing M-115 states the Terminal Unit (by Column Lines 8.8 & 9 and E.2 & G) is a 10" Unit Size. Please clarify the Unit size.

**Response:** Terminal Unit SAV 3-16 size is 10”.

67. **Question:** RFI 067: VAV Air Terminal Schedule Drawing M-702 states Terminal Unit SAV 3-17 as a 12" Unit Size, but Drawing M-116 states the Terminal Unit (by Column Lines 14.8 & 15 and B & C) is a 10" Unit Size. Please clarify the Unit size.

**Response:** Terminal Unit SAV 3-17 size is 12”.
68. **Question:** RFI 068: Missing specification on the Variable Refrigerant Volume (VRV) System. Please provide.
   **Response:** Spec will be updated.

69. **Question:** RFI 069: Detail 4/M-500 depicts the Common Inlet Mixing Plenum for Lab EF-3 & 4 sitting on a Concrete Curb. The Lab EF Specification 23 34 00-2.2DS.17 states to "provide 14 gauge Galvanized Steel Roof Curbs to support the Plenums". Please clarify.
   **Response:** Spec will be updated.

70. **Question:** RFI 070: The Vibration & Seismic Controls application schedule spec 23 05 48-2.6 for AHU-1 to 4 references using Spring Isolation Curbs, while Details 1 & 2/ M-500 depicts the AHU's base with Structural Factory Channels mounting directly onto the Concrete Pads. Please clarify.
   **Response:** Spring isolation curbs not required for AHU 1 to 4.

71. **Question:** RFI 071: The Vibration & Seismic Controls application schedule spec 23 05 48-2.6 for CU-1 to 4 references using Spring Mounts, while Detail 5/ M-500 depicts the CU's base with Factory Angle Channels mounting directly onto the Concrete Pads. Please clarify.
   **Response:** Spring mounts not required for CU 1 to 4.

72. **Question:** RFI 072: The Vibration & Seismic Controls application schedule spec 23 05 48-2.6 for EF-1 references using Spring Mounts, but Exhaust Fan Equipment Schedule M-700 has the EF-1 model as a Roof Exhauster with a Pre-Fab Curb. Please clarify.
   **Response:** Spring mounts not required for EF-1.

73. **Question:** RFI 073: The Vibration & Seismic Controls application schedule spec 23 05 48-2.6 for EF-3 & 4 references using Spring Mounts, while Detail 4/ M-500 depicts the EF's Plenum Base with Factory Angles mounting directly onto the Concrete Pad. Please clarify.
   **Response:** Spring mounts not required for EF-3 & -4.

74. **Question:** RFI 074: Detail 11/P-500, clarify the following with regards to this detail:
   1) detail is shown with seismic cable. Please confirm this is at seismic locations and not every location.
   2) Detail notes to use Stainless pipe clamps to the mount to the strut. Most other hardware and hangers are plated or galvanized. Please confirm this is needed as stainless due to added cost.
   **Response:** 1) Confirmed, seismic cables only required at seismic location; 2) Stainless steel not required.

75. **Question:** RFI 075: Detail 1/P-605, please fix valve box notation and sizing for the P & ID sheet to match P-113 & P-114 (or fix the drawings to match the P & ID).
   **Response:** Floor plans a diagram updated as part of this addendum.

76. **Question:** RFI 076: Please confirm that Project Admin permission is appropriate level access to BIM 360 GLUE for the District, the Construction Manager and the Design Team members on the L-630 New Brentwood Center project.
   **Response:** CONFIRMED
77. **Question:** RFI 077: The BIM Construction Model Requirements (Section 01316) mandate the contractor purchase licenses from Autodesk software to provide required BIM deliverables. We request software requirements be more lenient to allow contractors to utilize programs they typically use for coordination and fabrication as well as effectively participate in the BIM process as well as meet prescribed deliverables.

**Response:** Licenses not required from Autodesk software. Contractor may utilize programs typically used programs.

78. **Question:** RFI 078: Please confirm that the Ratcliff design Revit model will not be stripped of its sheets, section views, detail (annotation) views and any other pertinent information as outlined in Section 01316 because the design Revit model may not be adequate for the Contractor’s and subcontractors’ use requiring contractor to rebuild the model from scratch.

**Response:** The Ratcliff Revit model is for design and documentation. It will not be stripped of any information. However, General Contractor and subcontractors will need to provide their own additional overlay drawings, etc. (where required for each discipline) for more detailed documentation for Ratcliff review.

79. **Question:** RFI 079: Section 11.1.2 of the General Conditions - Specific Insurance paragraph (1) specifies a combined single limit of not less than $5,000,000 per occurrence with a project specific aggregate of 10,000,000 dedicated to the project. Paragraph (3) specifies an additional Excess Liability insurance policy with a limit of $4,000,000 for a combined total of $9,000,000 per occurrence and $14,000,000 aggregate. The standard Commercial General Liability policy is generally written using $1,000,000 per occurrence with a $2,000,000 aggregate. Excess policies are then provided to increase limits to an acceptable level. Will the District allow the bidder to use Excess Liability limits in any combination to meet the overall project requirement of $9,000,000 per occurrence $14,000,000 aggregate?

**Response:** Considering the dollar amount for this project is $40 Million, the District prefers to have $10,000,000 Aggregate; $5,000,000 Each Occurrence; Automobile is $5,000,000; Excess is Contractors Discretion; Workers Comp per statute.

80. **Question:** RFI 080: Section 11.1.3 of the General Conditions - Subcontractor Insurance Requirements. (a) of this section includes a $5,000,000 combined single limit followed by the number $1,000,000. Is the $5,000,000 an error given the limits specified in (b), (c) and (d)?

**Response:** Subcontractor limits of insurance coverage may be the Primary Contractors decision.

81. **Question:** RFI 081: Paragraph one of Section 9. Insurance requires that all insurers be authorized as “…admitted carriers…” in California. Most trade contractors (subcontractors) purchase their insurance from carriers who are authorized to do business in California and accepted by the California Department of Insurance as Non-Admitted insurers. Many if not most carry the highest Best Ratings.

**Response:** Bid Documents require “admitted carriers in California”.
# SECTION 00010
## TABLE OF CONTENTS

### VOLUME 00 – DIVISIONS 00-01

**DIVISION 00** \ PROCUREMENT AND CONTRACTING REQUIREMENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>00001</td>
<td>TITLE PAGE</td>
</tr>
<tr>
<td>00007</td>
<td>SEALS PAGE AND DSA FORM 103</td>
</tr>
<tr>
<td>00010</td>
<td>TABLE OF CONTENTS</td>
</tr>
<tr>
<td>00016</td>
<td>LMC COLLEGE COMPLEX MAP (Location for Pre-Bid Meeting)</td>
</tr>
<tr>
<td>00100</td>
<td>NOTICE INVITING BIDS (ADDENDUM #2)</td>
</tr>
<tr>
<td>00200</td>
<td>INSTRUCTIONS TO BIDDERS</td>
</tr>
<tr>
<td>00210</td>
<td>INFORMATION AVAILABLE TO BIDDERS</td>
</tr>
<tr>
<td>00300</td>
<td>BID PROPOSAL FORM (ADDENDUM #2)</td>
</tr>
<tr>
<td>00350</td>
<td>NON-COLLUSION AFFIDAVIT</td>
</tr>
<tr>
<td>00400</td>
<td>STATEMENT OF BIDDER’S QUALIFICATIONS</td>
</tr>
<tr>
<td>00450</td>
<td>CERTIFICATION OF SITE VISIT</td>
</tr>
<tr>
<td>00500</td>
<td>PAYMENT AND PERFORMANCE BOND</td>
</tr>
<tr>
<td>00510</td>
<td>NOTICE OF AWARD</td>
</tr>
<tr>
<td>00600</td>
<td>CONSTRUCTION AGREEMENT</td>
</tr>
<tr>
<td></td>
<td>PROJECT STABILIZATION AGREEMENT and AMENDMENT</td>
</tr>
<tr>
<td>00650</td>
<td>NOTICE TO PROCEED</td>
</tr>
<tr>
<td>00700</td>
<td>GENERAL CONDITIONS</td>
</tr>
</tbody>
</table>

**DIVISION 01** \ GENERAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>01010</td>
<td>SUMMARY OF WORK</td>
</tr>
<tr>
<td>01015</td>
<td>ADDITIONAL REQUIREMENTS FOR DSA-APPROVED PROJECTS</td>
</tr>
<tr>
<td>01030</td>
<td>ALTERNATES (ADDENDUM #2)</td>
</tr>
<tr>
<td>01050</td>
<td>FIELD ENGINEERING</td>
</tr>
<tr>
<td>01055</td>
<td>CONFORMANCE SURVEYING</td>
</tr>
<tr>
<td>01140</td>
<td>WORK RESTRICTIONS</td>
</tr>
<tr>
<td>01250</td>
<td>CONTRACT MODIFICATION PROCEDURES</td>
</tr>
<tr>
<td>01290</td>
<td>PAYMENT PROCEDURES</td>
</tr>
<tr>
<td>01300</td>
<td>LABOR COMPLIANCE PROGRAM</td>
</tr>
<tr>
<td>01305</td>
<td>DELAY AND EXTENSIONS TO THE WORK</td>
</tr>
<tr>
<td>01310</td>
<td>CONSTRUCTION SCHEDULING</td>
</tr>
<tr>
<td>01311</td>
<td>PROJECT MANAGEMENT AND COORDINATION</td>
</tr>
<tr>
<td>01312</td>
<td>PROJECT MEETINGS</td>
</tr>
<tr>
<td>01316</td>
<td>BUILDING INFORMATION MODELEING (BIM)</td>
</tr>
<tr>
<td>01318</td>
<td>DOCUMENT MANAGEMENT SYSTEM</td>
</tr>
<tr>
<td>01321</td>
<td>PHOTOGRAPHIC DOCUMENTATION (ADDENDUM #1)</td>
</tr>
<tr>
<td>01330</td>
<td>SUBMITTAL PROCEDURES</td>
</tr>
<tr>
<td>01340</td>
<td>ADMINISTRATIVE FORMS AND LOGS</td>
</tr>
</tbody>
</table>
VOLUME 01 – TECHNICAL SPECS, PREPARED BY RATCLIFF

DIVISIONS 02-14

DIVISION 02 - EXISTING CONDITIONS
02 41 00 Site Demolition

DIVISION 03 – CONCRETE
03 10 00 Concrete Forming
03 20 00 Concrete Reinforcing
03 25 20 Anchors and Dowels in Resin
03 25 30 Expansion Anchors
03 30 00 Cast-in-Place Concrete
03 35 00 Concrete Finishing
03 37 00 Concrete Polishing
03 39 00 Concrete Curing
03 54 16 Cement Underlayment
## DIVISION 04 – MASONRY
Not Used

## DIVISION 05 – METALS
05 12 00  Structural Steel  
05 12 19  Buckling Restrained Braces  
05 12 50  Architecturally Exposed Structural Steel  
05 31 00  Steel Decking  
05 35 00  Acoustical Decking  
05 40 00  Cold-Formed Metal Framing  
05 50 00  Metal Fabrications (ADDENDUM #1)  
05 70 05  Landscape Metalwork

## DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES
06 10 00  Rough Carpentry  
06 16 00  Sheathing  
06 20 23  Interior Finish Carpentry  
06 40 23  Architectural Woodwork  
06 64 00  Plastic Paneling

## DIVISION 07 - THERMAL AND MOISTURE PROTECTION
07 13 00  Sheet Waterproofing  
07 21 00  Building Insulation  
07 25 00  Weather Barriers  
07 26 16  Concrete Vapor Treatment  
07 28 00  Vapor Barrier  
07 46 00  Fiber Cement Siding and Trim  
07 46 46  Large Format Fiber Cement Panels  
07 54 19  PVC Single Ply Roofing  
07 61 00  Metal Roofing  
07 62 00  Sheet Metal Flashing and Trim  
07 72 00  Roof Accessories  
07 81 00  Applied Fireproofing  
07 84 00  Firestopping  
07 92 00  Joint Sealants  
07 95 13  Expansion Joint Cover Assemblies

## DIVISION 08 – OPENINGS
08 06 71  Door Hardware Sets  
08 11 13  Hollow Metal Doors and Frames  
08 11 16  Aluminum Frames  
08 14 00  Wood Doors  
08 31 13  Access Doors and Panels  
08 33 26  Overhead Coiling Grilles  
08 35 13  Side Folding Grilles
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>08 41 13</td>
<td>Interior Entrances and Storefronts</td>
</tr>
<tr>
<td>08 42 29.33</td>
<td>Sliding Automatic Entrances</td>
</tr>
<tr>
<td>08 43 13</td>
<td>Glazed Aluminum Curtain Walls</td>
</tr>
<tr>
<td>08 51 13</td>
<td>Aluminum Windows</td>
</tr>
<tr>
<td>08 71 00</td>
<td>Door Hardware</td>
</tr>
<tr>
<td>08 71 13</td>
<td>Automatic Door Operators</td>
</tr>
<tr>
<td>08 80 00</td>
<td>Glazing</td>
</tr>
<tr>
<td>08 90 00</td>
<td>Louvers</td>
</tr>
</tbody>
</table>

**DIVISION 09 – FINISHES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>09 22 16</td>
<td>Non-Structural Metal Framing</td>
</tr>
<tr>
<td>09 29 00</td>
<td>Gypsum Board</td>
</tr>
<tr>
<td>09 30 00</td>
<td>Tiling</td>
</tr>
<tr>
<td>09 51 23</td>
<td>Acoustical Ceilings</td>
</tr>
<tr>
<td>09 54 29</td>
<td>Specialty Suspended Ceilings</td>
</tr>
<tr>
<td>09 65 13</td>
<td>Resilient Base and Accessories</td>
</tr>
<tr>
<td>09 65 43</td>
<td>Resilient Flooring</td>
</tr>
<tr>
<td>09 67 23</td>
<td>Resinous Flooring</td>
</tr>
<tr>
<td>09 68 13</td>
<td>Tile Carpeting</td>
</tr>
<tr>
<td>09 72 00</td>
<td>Wall Coverings</td>
</tr>
<tr>
<td>09 83 00</td>
<td>Acoustic Finishes</td>
</tr>
<tr>
<td>09 91 00</td>
<td>Painting</td>
</tr>
<tr>
<td>09 96 00</td>
<td>High Performance Coatings</td>
</tr>
</tbody>
</table>

**DIVISION 10 – SPECIALTIES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 11 00</td>
<td>Visual Display Units</td>
</tr>
<tr>
<td>10 12 00</td>
<td>Display Cases</td>
</tr>
<tr>
<td>10 14 00</td>
<td>Signage</td>
</tr>
<tr>
<td>10 21 13</td>
<td>Toilet Compartments</td>
</tr>
<tr>
<td>10 26 00</td>
<td>Wall Protection</td>
</tr>
<tr>
<td>10 28 00</td>
<td>Toilet Accessories</td>
</tr>
<tr>
<td>10 44 00</td>
<td>Fire Protection Specialties</td>
</tr>
<tr>
<td>10 51 13</td>
<td>Metal Lockers</td>
</tr>
<tr>
<td>10 55 00</td>
<td>Postal Specialties</td>
</tr>
<tr>
<td>10 56 13</td>
<td>Metal Storage Shelving</td>
</tr>
</tbody>
</table>

**DIVISION 11 – EQUIPMENT**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 31 00</td>
<td>Appliances</td>
</tr>
<tr>
<td>11 53 10</td>
<td>Laboratory Casework and Other Furnishings</td>
</tr>
<tr>
<td>11 53 13</td>
<td>Fume Hoods &amp; Other Air Containment Units</td>
</tr>
<tr>
<td>11 53 43</td>
<td>Laboratory Service Fittings and Fixtures</td>
</tr>
<tr>
<td>11 53 50</td>
<td>Laboratory Equipment</td>
</tr>
<tr>
<td>11 61 50</td>
<td>Controlled Environment Rooms</td>
</tr>
</tbody>
</table>
DIVISION 12 – FURNISHINGS
12 24 13 Window Shades (ADDENDUM #2)

DIVISION 13 – SPECIAL CONSTRUCTION Not Used
DIVISION 14 – CONVEYING SYSTEMS Not Used

VOLUME 02 DIVISIONS 21-33
DIVISION 21 – FIRE SUPPRESSION
21 10 00 Water Based Fire Suppression System

DIVISION 22 – PLUMBING
22 00 00 Plumbing
22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment
22 10 00 Plumbing Piping & Valves (ADDENDUM #2)
22 20 00 Plumbing Specialties
22 30 00 Plumbing Equipment
22 40 00 Plumbing Fixtures

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)
23 05 00 Common Work Results for Mechanical (ADDENDUM #2)
23 05 13 Common Motor Requirements for HVAC Equipment
23 05 29 Hangers Supports and Seismic Restraint for HVAC Piping and Equipment (ADD #2)
23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment
23 05 90 Testing For HVAC
23 05 93 Balancing for HVAC
23 07 00 HVAC Insulation (ADDENDUM #2)
23 09 01 Laboratory Controls System (ADDENDUM #2)
23 21 13 Hydronic Piping and Valves (ADDENDUM #2)
23 21 14 Hydronic Systems for HVAC
23 21 15 Chemical (Water) Treatment
23 21 23 Hydronic Pumps
23 22 02 Heating Hot Water Boilers
23 22 04 Boiler Flues and Accessories
23 24 20 Air Cooled Electric Chiller
23 29 00 Variable Frequency Drives
23 30 00 HVAC Air Distribution (ADDENDUM #2)
23 34 00 HVAC Fans (ADDENDUM #2)
23 36 00 Air Terminal Units
23 73 00 Air Handling Units (ADDENDUM #2)
23 73 05 Split-Air Conditioning Unit System–VRV System (ADDENDUM #2)
DIVISION 25 – INTEGRATED AUTOMATION
25 00 00 Building Automation System

DIVISION 26 – ELECTRICAL
26 01 26 Field Test and Operational Test
26 05 00 Common Work for Electrical
26 05 02 Basic Materials and Methods
26 05 29 Hangers Supports Anchors & Seismic Restraints for Electrical Systems
26 05 43 Underground Electrical Construction
26 05 48 Vibration and Seismic Controls for Electrical Systems
26 05 73 Power System Study
26 05 74 Electrical Systems Firestopping
26 22 13 Dry Type Transformers - Energy Efficient Type
26 24 16 Panelboards
26 24 18 Switchboards
26 29 13 Low-Voltage Motor Controllers
26 33 23 Central Battery Inverter System
26 43 13 Surge Protection Devices
26 50 20 Lighting Controls
26 51 00 Interior Lighting

DIVISION 27 – COMMUNICATIONS
27 05 00 Common Work Results for Communications
27 05 26 Grounding and Bonding for Communications Systems
27 05 29 Hangers and Supports for Communications System
27 05 33 Conduits and Backboxes for Communications Systems
27 05 36 Cable Trays for Communications Systems
27 05 43 Underground Ducts and Raceways for Communications Systems
27 05 48 Noise and Vibration for Communications Systems
27 05 53 Identification for Communications Systems
27 10 00 Structured Cabling, Basic Materials & Methods
27 11 13 Communications Entrance Protection
27 11 16 Communications Cabinets, Racks, Frames and Enclosures
27 11 19 Communications Termination Blocks and Patch Panels
27 11 23 Communications Cable Management
27 13 00 Communications Indoor Backbone Cabling
27 14 00 Communications Outside Plant Backbone Cabling
27 15 00 Communications Horizontal Cabling
27 41 16 Audiovisual Systems and Equipment
27 41 23 Communications Broadband Systems

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY
28 05 00 Common Work Results for Electronic Safety and Security
28 05 13 Conductors and Cables for Electronic Safety and Security
28 05 26  Grounding and Bonding for Electronic Safety and Security
28 05 28  Pathways for Electronic Safety and Security
28 13 00  Access Control and Alarm Systems
28 23 00  Visual Surveillance
28 31 13  Fire Alarm System

DIVISION 31 – EARTHWORK
31 10 00  Site Prep & Plant Protection
31 10 10  Site Clearing and Stockpiling
31 11 00  Clearing and Grubbing
31 23 00  Excavation and Fill
31 23 33  Trenching and Backfilling
31 25 00  Erosion and Sedimentation Control

DIVISION 32 – EXTERIOR IMPROVEMENTS
32 11 00  Base Courses
32 12 00  Flexible Paving
32 13 12  Site Concrete
32 15 45  Stabilized Granular Paving
32 17 23  Pavement Markings
32 31 10  Metal Gates
32 31 13  Chain Link Fences and Gates (New Section ADDENDUM #2)
32 33 00  Site Furnishings (ADDENDUM #2)
32 80 00  Irrigation (ADDENDUM #2)
32 90 00  Planting
32 91 18  Landscape Boulders

DIVISION 33 – UTILITIES
33 05 16  Utility Structures
33 10 00  Water Utilities
33 30 00  Sanitary Sewerage Utilities
33 40 00  Storm Drainage Utilities

VOLUME 03 Cutsheets
• APPENDIX A – Light Fixture Cutsheets
• APPENDIX B – Plumbing Fixture Cutsheets
• APPENDIX C – Fire Alarm Listings and Cutsheets

DRAWINGS PREPARED BY RATCLIFF

END OF SECTION 00010
NOTICE INVITING BIDS

Los Medanos College
L-630 New Brentwood Center
1351 Pioneer Square
Brentwood, California, 94542

NOTICE IS HEREBY GIVEN that the Governing Board of the Contra Costa Community College District (District), Martinez, California, will receive sealed bid proposals for the furnishing of all labor, materials, equipment, transportation and services for the construction of the project entitled L-630 New Brentwood Center

The District has pre-qualified General Contractors for this project, and the list of pre-qualified General Contractors can be found on the District’s web site: https://insite.4cd.edu/webapps/PurchasingViewbids/

Only Pre-Qualified Contractors are allowed to bid as Prime Contractors on this project. The District does not prequalify Subcontractors.

Construction Cost Estimate (Range): $35,000,000.00 to $43,000,000.00;
California License Required: B - General Building Contractor

In general, the Work consists of the construction of one-story, 54,973 GSF, fully sprinklered educational and administration facility. The building is designed as four wings-laboratory, Classroom, Administration and Student Commons and Classrooms. Site work includes surface parking and landscaping, bio retention areas, landscaped courtyards and paths and a fire access lane.

The District does not provide hardcopies of bid documents or reimburse cost of printing, delivery, or any expenses related to the bidding process.

For information directly from the District, you may also log on to the District Website: http://www.4cd.edu/webapps/PurchasingViewBids/default.aspx. Project documents available include, but are not limited to, plans, specifications, addenda, bidders lists, bid results, etc., and can be viewed on this District webpage. Builders Exchanges around Northern California are also notified.

This project is subject to the terms and conditions of a Project Stabilization Agreement (PSA) executed between the Contra Costa Community College District and the Contra Costa County Building & Construction Trades Council ("Council") and its affiliated local signatory unions.

All questions related to this project must be in writing and are directed to:
Jovan Esprit – Contracts Manager (CCCCD)
Contra Costa Community College District
500 Court St., Martinez, CA 94553
Email: jespirit@4cd.edu

Each bid shall be made on the bid form, which is included in the Bid Documents and when submitted, shall be accompanied by a Bid Bond or Certified Cashier’s Check in the amount of 10% of bid (made payable to the Contra Costa Community College District). The District reserves the right to forfeit Bid Bond submitted for failure of the successful bidder to secure Payment & Performance Bonds.

IMPORTANT INFORMATION:
Contra Costa Community College District
Los Medanos College
L-630 New Brentwood Center
Pre-Bid Meeting and Job Walk, Date / Time: Monday April 9, 2018 at 1:00PM (MANDATORY)
Pre-Bid Meeting Location: Los Medanos College
2700 East Leland Drive Pittsburg, CA 94565
Room CC3-361 (See LMC College Complex Map)

PLEASE NOTE: Immediately following the Pre-Bid meeting at Los Medanos College, a Site Visit will follow at the
PROJECT LOCATION in Brentwood.
All potential bidders shall meet at the Brentwood Campus, 1351 Pioneer Square, Brentwood, CA 94542.

Please remember to obtain a Certification of Site Visit, signed by the District Representative, prior to
leaving the Brentwood location.

Last Date / Time for Bidder’s
Requests for Information: April 20, 2018 (prior to 5:00pm)
Last Day to Issue Addendum: May 3, 2018
Bids Due No Later Than, Date / Time: May 10, 2018 (prior to 2:00PM)
Bids Must Be Received at: Contra Costa Community College District (Lobby)
500 Court St, Martinez, CA 94553
Attn: Jovan Esprit – Contracts Manager (CCCCD)

Bids must be received by the District prior to the time and by the date noted above. Bids that are not received
by the District prior to the time and by the date noted above will not be accepted, and will be returned to the
Bidder unopened.

The successful bidder will be required to furnish a labor and material bond in an amount equal to one hundred
percent (100%) of the contract price and a faithful performance bond in an amount equal to one hundred percent
(100%) of the contract price, said bonds to be secured from a surety company acceptable to the Contra Costa
Community College District and authorized to execute such surety in the State of California.

This project is a public works project and is subject to prevailing wage rate laws. A copy of the prevailing rates of
wages is on file with the Contracts & Purchasing Office of the Contra Costa Community College District. Said rates
of wages shall be included in the contract for the work by this reference.

Attention is directed to Section 4100 through 4113 of the Public Contract Code concerning Subcontractors, with
emphasis on Section 4104, known as the “Subletting and Subcontracting Fair Practices Act, effective July 1, 2014.

Attention is directed to Labor Code Section 1725.5 regarding Department of Industrial Relations (DIR) contractor
registration process including registration criteria and implementation of DIR registration requirements. Labor
Code Section 1771.7 establishes contractor’s obligation to submit Certified Pay Roll (CPR) to the Department of
Labor and Standards Enforcement (DLSE) and public works monitoring and enforcement. Labor Code Section
1773.3 requires the District to submit a PWC-100 to DIR for all public works contract awarded effective January
1, 2015.

Attention is directed to Section 00600, Construction Agreement, Article 5, and GENERAL CONDITIONS, Article 8,
paragraphs 8.4.1 and 8.4.2, regarding liquidated damages. Liquidated Damages shall be set for $5000 Dollars for
each calendar day the work is delayed beyond the Contract Substantial Completion date. The Governing Board of
the Contra Costa Community College District reserves the right to reject any and all bids and/or waive any
informality or irregularity in any bid received. No bidder may withdraw their Bid for a period of ninety (90) days
after the date set for opening thereof.

END OF SECTION 00100
SECTION 00300
BID PROPOSAL FORM

PROJECT NUMBER / NAME: L-630 New Brentwood Center

CAMPUS / LOCATION: New Brentwood Center 1351 Pioneer Square Brentwood, CA 94513

DISTRICT: CONTRA COSTA COMMUNITY COLLEGE DISTRICT
500 Court St, Martinez, CA 94553
Herein Referred to as "District"

1. INTRODUCTION

A. The Bidder proposes to perform the Work for the Contract Price and within the proposed Contract Time, based upon an examination of the site and the Bid and Contract Documents.

B. The Bidder certifies this Bid is submitted in good faith.

C. The Bidder agrees that the Contract Price and other proposed terms will be considered in evaluating Bids and may be negotiated and adjusted before awarding of Contract.

D. The signed copy of the Certification of the Visit to the Site shall be attached to the Bid Form Submittal.

E. A fully executed Statement of Bidder’s Qualifications signed by an authorized officer of the Bidder submitting the Bid shall be attached to the Bid Form.

F. A fully executed Non-Collusion Affidavit signed by an authorized officer of the Bidder submitting Bid shall be attached to the Bid Form.

G. The District shall award the contract to the lowest responsive and responsible Bidder. The evaluation of the low bid shall be based on the total of Item 2.A Base Bid minus Deductive Alternates 2.B.1, 2.B.2, 2.B.3, 2.B.4, 2.B.5a, 2.B.5b and 2.B.6.

H. The District reserves the right to apply the Deductive Alternates to the Contract at Contract Award or through Change Orders as budget allows.

2. CONTRACT PRICE

A. BASE BID L-630 New Brentwood Center

For labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete the general construction in accordance with the Contract Documents, for a stipulated Contract Price in the amount of:

_________________________________________________ Dollars ($_____________________)
B. **DEDUCTIVE ALTERNATES**

1. **REPLACE ASPHALT PARKING LOT.**

   Base Bid: Construct parking lots using AC paving, concrete curbs, parking lighting, and ticket machines as indicated on Drawings and Specifications.

   Alternate: Construct portion of parking lot identified on Sheet L-100 using recycled AC paving instead of specified AC paving and eliminate concrete curbs in this area and install 2,160 LF of large salvaged wood timbers (nominal size: 8x10 inches, minimum 9-foot lengths). Timbers shall be all one species, rot and insect resistant (eucalyptus or approved equal) and shall contain no toxic or poisonous materials. Timbers shall be pinned at minimum (2) locations per timber. Parking lighting and ticket machines remain in contract.

   Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

   _______________________________________________ Dollars ($____________________)

2. **DELETE SPEED TABLE BETWEEN SITE AND PIONEER SQUARE PARK AND PROVIDE CROSSWALK STRIPING ONLY.**

   Base Bid: Construct speed table and crosswalk striping between site and Pioneer Square Park as indicated on Drawings and Specifications.

   Alternate: Eliminate speed table. Specified crosswalk striping shall be installed on road surface. Alternate requires addition of 18-foot wide accessible curb ramp, similar to City of Brentwood Detail ST-21a Type “A” ramp as shown on Sheet C-703.

   Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

   _______________________________________________ Dollars ($____________________)

3. **DELETE METAL PANEL AT TRASH ENCLOSURE, REPLACE WITH FENCING.**

   Base Bid: Construct steel frame and metal panel enclosure screen and gates as indicated on Drawings and Specifications.

   Alternate: Eliminate steel frame and metal panel enclosure screen and gates. Construct vinyl-coated chain link fencing and gates with privacy slats per Specification Section 323113 Chain Link Fence and Gates. Fencing shall match steel frame enclosure configuration, dimensions, and gate sizes.

   Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

   _______________________________________________ Dollars ($____________________)
4. **DELETE METAL PANEL AT TRANSFORMER ENCLOSURE, REPLACE WITH FENCING**

Base Bid: Construct steel frame and metal panel enclosure screen and gate as indicated on Drawings and Specifications.

Alternate: Eliminate steel frame and metal panel enclosure screen and gate. Construct vinyl-coated chain link fencing and gates with privacy slats per Specification Section 323113 Chain Link Fence and Gates. Fencing shall match steel frame enclosure configuration, dimensions, and gate sizes.

Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

____________________________________________ Dollars    ($______________________)

5. a. **REDUCE PERIMETER HYDROSEED AND ASSOCIATED TEMPORARY IRRIGATION, AREA A.**

Base Bid: Construct hydroseed and temporary irrigation as indicated on Drawings and Specifications.

Alternate: Eliminate portions of hydroseed and temporary irrigation area east of parking lot as identified on Sheet L-100.

Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

____________________________________________ Dollars    ($______________________)

b. **REDUCE PERIMETER HYDROSEED AND ASSOCIATED TEMPORARY IRRIGATION, AREA B.**

Base Bid: Construct hydroseed and temporary irrigation as indicated on Drawings and Specifications.

Alternate: Eliminate portion of hydroseed and temporary irrigation area west of parking lot as identified on Sheet L-100.

Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

____________________________________________ Dollars    ($______________________)

6. **CHANGE REFRIGERATION UNITS AT BOOKSTORE TO OFOI**

Base Bid: Provide and install specified refrigeration units at bookstore as indicated on Drawings and Specifications.

Alternate: Specified refrigeration units at bookstore shall be owner-furnished owner-installed (OFOI). Construct all utilities ready for installation of refrigeration unit by others.

Provide all labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes and other costs necessary to complete this Alternate construction in accordance with the Contract Documents:

____________________________________________ Dollars    ($______________________)

Contra Costa Community College District
Los Medanos College
L-630 New Brentwood Center

Page 3 of 7
Section 00300 - Bid Proposal Form
ADDENDUM #2
3. **COMPLETION TIME**

   A. For establishing the Date of Substantial Completion and Final Completion, the Contract Time for the Base Bid and Alternates is as listed in Section 00600, Construction Agreement. This time may be subject to modification to facilitate the work as mutually agreed upon at a later date.

   B. The Bidder certifies that the Bid is based on the Contract Time for completion as stated above and in the Contract Documents. Bidder further certifies that the Base Bid amount is sufficient to cover all labor, materials, central office and construction site overhead, profit, and all other costs related to the completion of the Project for the entire Project construction time for both the General Contractor and all Subcontractors, as stated above in paragraphs 2 and 3.

4. **ADDENDA**

   A. The Bidder acknowledges receipt of the following Addenda and certifies the Bid has provided for all modifications and considerations required therein.

      None [    ]

      Addendum No.: ________ dated _________________

      Addendum No.: ________ dated _________________

      Addendum No.: ________ dated _________________

      Addendum No.: ________ dated _________________

      Addendum No.: ________ dated _________________

      Addendum No.: ________ dated _________________

   B. List of Additional Addenda Attached: Yes [    ] No. [    ].

5. **DESIGNATION OF SUBCONTRACTORS**

   A. The Bidder has set forth a complete list indicating the type of work, name, and business address of each Subcontractor who will perform work in excess of one-half of one percent of the Contract Price.

   B. Any portion of the work in excess of the specified amount having no designated Subcontractor shall be performed by the Bidder.

   C. Substitution of listed Subcontractors will not be permitted unless approved in advance by the District.

   D. Prior to signing the Contract, the District reserves the right to reject any listed Subcontractor.
E. The Bidder and all Subcontractors, at any and all tiers, shall be required to sign and submit to the District an Agreement to be Bound to the Project Stabilization Agreement that is a part of these Contract Documents.

**SUBCONTRACTOR TYPE OF WORK**

(1)  
(2)  
(3)  
(4)  
(5)  

F. Complete list of Subcontractors is attached:  Yes [ ] No [  ]

G. Continuation list of Subcontractors is attached:  Yes [ ] No [  ]

H. Within 24 hours after the deadline for submission of Bids, Bidders shall submit each subcontractor’s License Number, Business Address, and percentage of contract work to be performed by each listed subcontractor.

6. **ACCEPTANCE AND AWARD**

A. The District reserves the right to reject this Bid and to negotiate changes before or after execution of the Contract. This Bid shall remain open and shall not be withdrawn for a period of 90 days after Bid Opening date.

B. If written Notice of Award of this Bid is mailed or delivered to the Bidder within 90 days after the date set for the receipt of this Bid, or other time before it is withdrawn, the Bidder will execute and deliver to the District a Contract prepared by District with the required Surety Bonds and Certificates of Insurance, within 10 days after personal delivery or deposit in the mail of the Notice of Award.

C. Notice of Award - or request for additional information may be addressed to the Bidder at the address provided.

7. **BID SECURITY**

A. The required 10 percent (10%) Bid Security for this Bid is attached in the form of:

( ) Bid Bond Issued By: ________________________________

( ) Certified or Cashier’s Check No. ________________________________

Issued by: ________________________________
8. **BIDDER'S BUSINESS INFORMATION**

A. **Individual [ ]:**

   Personal Name: ________________________________

   Business Name: ________________________________

   Address: _______________________________________

   __________ Zip Code: __________

   Telephone: ______________________________________

   Fax Number: ______________________________________

B. **Partnership [ ]:**

   Co-partners' Names: ________________________________

   Business Name: ________________________________

   Address: _______________________________________

   _______ Zip Code: __________

   Telephone: ______________________________________

   Fax Number: ______________________________________

C. **Corporation [ ]:**

   Firm Name: ______________________________________

   Address: _______________________________________

   _______ Zip Code __________

   Telephone: ______________________________________

   Fax Number: ______________________________________

   State of Incorporation: ________________________________

   President: ______________________________________

   Secretary: ______________________________________

   Treasurer: ______________________________________
Manager: ____________________________________________

D. Power of Attorney: Name: ____________________________

Title: ______________________________________________

E. Contractor License No. ________State of _____________

F. Bidder is submitting this proposal on behalf of a Joint Venture. Names, license numbers, and relevant information are given on a separate attachment: Yes [ ] No [ ].

G. Upon request, furnish appropriate documentation to substantiate and/or support the data given.

9. The undersigned hereby certifies under penalty of perjury under the laws of the State of California that all the information submitted by the Bidder in connection with this Bid and all the representations herein made are true and correct.

Executed this day of ____________________________

_______________________________

Contractor’s License No. Expiration Date

_______________________________

Firm Name

_______________________________

Signature

_______________________________

By (Print or Type Name)

_______________________________

Title

End of Section 00300
PART 1 – GENERAL

1.1 RELATED DOCUMENTS
   A. All Contract Documents shall be reviewed for applicable provisions related to the provisions in this document, and provisions in the General Conditions and other Division 1 Specification Sections shall apply to this Section without limitation.

1.2 RELATED REQUIREMENTS SPECIFIED IN OTHER SECTIONS
   1. Section 00200 – “Instructions to Bidders”
   2. Section 00300 – “Bid Proposal Form”
   3. Section 01010 – “Summary of Work”
   4. Section 01290 – “Payment Procedures”
   5. Section 01310 – “Construction Scheduling”
   6. Section 01311 – “Project Management and Coordination”
   7. Section 01330 – “Submittal Procedures”
   8. Section 01740 – “Warranties and Guarantees”
   10. Divisions 2 through 33 Sections for Alternates requirements for the work in those Sections.

1.3 SUMMARY
   1. This Section includes administrative and procedural requirements governing Alternates. Each Alternate is identified by number and describes the basic changes to be made in the Work.

1.4 REQUIREMENTS
   1. Alternate pricing quoted on the Bid Proposal Form will be reviewed by the District, and accepted or rejected at District’s sole option. Any accepted Alternate(s) will be identified in the District-Contractor Agreement.
   2. See the Bid Proposal Form, Section 00300. Item 1.G, for District Bid evaluation procedure.
   3. All Alternates are either “additive” or “deductive” or “no change” to the Lump Sum Base Bid. The Contractor shall quote the amount for each Alternate in the space provided on the Bid Proposal Form.
   4. Failure to either quote an Alternate amount or the insertion of the words “no bid,” “none” or words of similar import, may be considered as not completing the Bid Proposal Form and may constitute disqualification of the entire bid at District’s sole discretion. Bidders may insert a zero dollar amount ($0.00) in the Alternate price line of the Bid Proposal Form if the Bidder proposes to perform the Work of the Alternate with no additional change to the Contract Sum.
   5. The Base Bid and the Alternates are exclusive in their scope of Work. There is no overlap between or among the Base Bid and the Alternates.
   6. The cost of any item of work shall be included only once, in the Base Bid or in the Alternates.
   7. Each Alternate is intended to cover all of the Work required for a complete, finished job.
      1. Alternate Work includes all miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of the
Alternate, but necessary to complete the Alternate Work according to the Contract Documents.

1.5 PROCEDURES

1. Modify or adjust affected adjacent Work as necessary to completely integrate Work of each accepted Alternate into the Project.

2. Notification: Immediately following award of the Contract, Contractor shall notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.

3. The District reserves the right to reinstate Alternates at any time within 90 calendar days after the Notice to Proceed without any increase or decrease in Contract Price (beyond the amount of the Alternates(s) listed in Section 00300, Part 2), or any increase in Contract Time.

4. Execute accepted Alternate(s) under the same conditions as other Work of this Contract.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF ALTERNATES

   a. Deductive Alternates 2.B.1: Replace asphalt parking lot.
   b. Deductive Alternates 2.B.2: Delete speed table between site and Pioneer Square Park and provide crosswalk striping only.
   c. Deductive Alternates 2.B.3: Delete metal panel at trash enclosure, replace with fencing.
   d. Deductive Alternates 2.B.4: Delete metal panel at transformer enclosure, replace with fencing.
   e. Deductive Alternates 2.B.5a: Reduce perimeter hydroseed and associated temporary irrigation, Area A.
   f. Deductive Alternates 2.B.5b: Reduce perimeter hydroseed and associated temporary irrigation, Area B.
   g. Deductive Alternates 2.B.6: Change refrigeration units at bookstore to OFOI.

PART 3 - EXECUTION

3.1 GENERAL

1. Execute accepted alternates under the same conditions as other Work of this Contract.

2. Coordination: Modify or adjust affected Work as required to completely and fully integrate that Work into the Project.

END OF SECTION 01030
PART 1- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Motor-operated roller shades with single rollers.
2. **Motor-operated roller shades with double rollers.**
3. Manually-operated roller shades with single rollers.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
2. Section 07 92 00 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.
3. Section 09 22 16 "Non-structural Metal Framing" for metal backing plates for mounting roller shades and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
2. Plan drawings showing location of each shade.
3. Details of all shade types.

C. Samples for Verification: For each type of roller shade.

1. Shadeband Material: Not less than 10 inches square. Mark inside face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
3. Installation Accessories: Full-size unit, not less than 10 inches long.

D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material, signed by product manufacturer.

C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.
1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 – PRODUCTS

1.10 MANUFACTURERS

A. Basis of Design: Products by MechoSystems; 42-03 35th Street, Long Island City, NY 11101. Local rep: Lyndsey Harper. Email: Lyndsey.harper@MechoSystems.com

B. Or equal, by one of the following:

1. Lutron Electronics Co., Inc.
2. Vertilux Ltd.

C. Source Limitations: Obtain roller shades from single source from single manufacturer.

1.11 Electronic Drive Unit (EDU) Intelligent Encoded EDU, and Control System: Tubular, asynchronous (non-synchronous) EDU’s, with built-in reversible capacitor operating at 120VAC/60Hz, (230VAC/50Hz) single phase, temperature Class B, thermally protected, totally enclosed, maintenance free with line voltage power supply equipped with locking disconnect plug assembly furnished with each EDU.

A. Quiet [42 – 46 dB] within 3 feet open air.

B. Conceal EDU’s inside shade roller tube.

C. Conceal EDU’s inside shade roller tube.

D. Maximum current draw for each shade EDU of 0.9Amps at 120VAC.

E. Use EDU’s rated at the same nominal speed for all shades in the same room.

F. Use EDU’s with minimum of 34RPM, that shall not vary due to load / lift capacity.
G. Total hanging weight of shade band shall not exceed 80 percent of the rated lifting capacity of the shade EDU and tube assembly.

H. EDU System: (software, two-way communication): Specifications and design are based on the Intelligent EDU Control System, WhisperShade®IQ® System) as manufactured by MechoSystems. Other systems may be acceptable providing all of the following performance capabilities are provided. EDU and control systems not in complete performance criteria shall not be accepted as equal systems. EDU shall support two methods of control.

1. Local Dry Contact Control Inputs:
   a. EDU shall be equipped with dry contact inputs to support moving the EDU/shade to the upper and lower limits.
   b. EDU shall be equipped with dry contact inputs to support moving the EDU/shade to local switch preset positions.
   c. Shall support configuring the EDU under protected sequences so that a typical user would not change the EDU’s setup. At a minimum the configuration should include setting limits, setting custom presets and configuring key modes of operation.

2. Network Control:
   a. EDU shall be equipped with a bi-directional network communication capability in order to support commanding the operation of large groups of shades over a common backbone. The network communication card shall be embedded into the tubular EDU assembly.

I. Upper and lower stopping points (operating limits) of shade bands shall be programmed into EDU’s using either a hand held removable program module / configurator or a local switch.

J. Alignment Positions: Each EDU shall support a minimum of 133 repeatable and precisely aligned shade positions (including limits and presets).

1. All shades on the same switch circuit or with the same network group address with the same opening height shall align at each limit or preset (intermediate stopping position) when traveling from any position, up or down.
2. Shades of differing heights shall have capability for custom, aligned intermediate stop positions when traveling from any position, up or down.
3. Alignment of shades mechanically aligned on the same EDU shall not exceed +/- 0.125 inches (3.175mm) when commanded to the same alignment position.
4. Alignment of shades on adjacent EDU’s shall not exceed +/- 0.25” inches (6.35mm) when commanded to the same alignment position.
5. **Local Switch Presets:** A minimum of 3 customizable preset positions shall be accessible over the local dry contact control inputs and over the network connection.

   a. Upon setting the limits for the shade EDU these preset positions shall automatically default to 25%, 50% and 57% of the shade travel.
   b. These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module / configurator or local switch shall be capable of customizing the position of these presets.

6. **Network Presets:** A minimum of 29 customizable preset positions (including the 3 local switch presets) shall be accessible via network commands.

   a. Upon setting the limits for the shade EDU these preset positions shall automatically default to the lower limit unless customized elsewhere.
   b. These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module / configurator shall be capable of customizing the position of these presets.

K. **Network Control:**

1. The system shall have the capability of two-way digital communication with the EDU's over a common backbone.
2. Each EDU shall possess 8 addresses capable of being employed for various levels of group control. These addresses shall be configurable via a handheld configurator and/or a PC controller. A 9th unique address shall enable the EDU(s) to be independently controlled and configured over the network via a handheld configurator and/or a PC controller.
3. **Low Voltage Communication Network Implementation.**

   a. The low voltage network shall employ a bus topology with daisy chained network connections between nodes over a CAT5 cable (4 UTP) or over a 2 UTP cable employing at least 1 pair at 16 AWG for power and 1 pair at 22 AWG for data.
   b. The low voltage network (+/- 13VDC) shall be powered by the nodes attached to it. These nodes could be line voltage powered EDU's attached to 120 VAC or 230 VAC. Alternatively, low voltage nodes shall be powered typically by a centralized low voltage power supply. If a CAT5 network cable is employed and the node draws less than 1W then the node may be powered by DC power supplied by an associated line voltage EDU.
   c. **Network Capacity:** 4000 ft max, 250 nodes max

   1) The number and size of a centralized DC supply shall vary depending upon the network requirements.
L. Operating Modes:

1. Uniform or Normal Modes of Operation:
   a. Uniform mode shall allow for shades to only move to defined intermediate stop positions to maintain maximum uniformity and organization.
   b. Normal Mode shall allow for shades to move to both intermediate stop positions, plus any position desired between the upper and lower limits as set by the installer.

M. Wall Switches:

1. Intelligent switches may be installed anywhere on the bus line. Each IS shall be capable of storing one control level address to be broadcast along the bus line.
2. An address that is transmitted by either a switch or central controller shall be responded to by those EDU’s with the same address in their control table.
3. IS shall provide for interface with other low voltage input devices via a set of dry contact terminals located on the switch.
4. Standard switch or IS may control an individual, sub-group or group of EDU’s in accordance with the address in each EDU.

1.12 MOTOR-OPERATED SHADES WITH SINGLE ROLLERS

A. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Electric Motor: WhisperShade IQ2 - Quiet, intelligent encoded EDU, tubular, enclosed in rollers.
   a. Electrical Characteristics: Single phase, 120VAC. 60 Hz.
3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
   a. Keyed Control Station: Keyed, momentary-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
b. Color: As selected by Architect from manufacturer's full range.

4. Crank Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.

5. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.

6. Wall Switches:
   a. Intelligent switches may be installed anywhere on the bus line. Each IS shall be capable of storing one control level address to be broadcast along the bus line.
   b. An address that is transmitted by either a switch or central controller shall be responded to by those EDU’s with the same address in their control table.
   c. IS shall provide for interface with other low voltage input devices via a set of dry contact terminals located on the switch.
   d. Standard switch or IS may control an individual, sub-group or group of EDU’s in accordance with the address in each EDU.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.

1. Roller:
   a. Drive-End Location: To be reviewed in shop drawings by the Architect.
   b. Direction of Shadeband Roll: Regular, from back of roller.

2. Shadeband-to-Roller Attachment:
   a. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a “snap-on” snap-off spline mounting, without having to remove shade roller from shade brackets.
   b. Mounting Spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
   c. Any method of attaching shade band to roller tube that requires the use of adhesive, adhesive tapes, staples, and/or rivets, does not meet the performance requirements of this specification and shall not be accepted.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
E. Shadebands, as indicated on drawings:

2. Shadeband Bottom (Hem) Bar: Concealed Steel or extruded aluminum. Fabric to be heat sealed on all sides

F. Installation Accessories:

1. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
2. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recesses or pockets and for snap-in attachment to wall clip without fasteners.
3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.

1.13 MOTOR-OPERATED, DOUBLE-ROLLER SHADES

A. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Electric Motor: Manufacturer's standard tubular, enclosed in rollers.
3. Wireless Daylight control system:
   a. Wireless PV Sunlight activated control system:
      1) 5 brightness adjustable stop positions.
      2) EnOcean wireless switch option.
   3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote control activation of shades:
      a. Keyed Control Station: Keyed, maintained-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
b. Individual Switch Control Station: maintained-contact, wall-switch-operated control station with open, close, and center-off functions.
   1) Switch Positions: three.
   2) Switch Style: rocker.

c. Group Control Station: maintained-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center-off functions for single-switch group control.

d. Individual/Group Control Station: maintained-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center-off functions for individual and group control.

e. Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.

f. Infrared Control: System consisting of concealed receiver complete with external eye and connecting modular cable and two portable, multiple-channel transmitters with separate buttons to open and close individual or groups of shades, to open and close shades simultaneously, and to stop shade movement.
   1) Capacity: Up to ten individual or groups of shades.

g. Timer Control: Clock timer, 24-hour programmable for regular events.

h. Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features; isolated from voltage spikes and surges.

i. Color: samples from manufacturer's standard range of colors to be provided for architectural review.

4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.

5. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.

6. Operating Features:
   a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
   b. Capable of interface with audiovisual control system.
   c. Capable of accepting input from building automation control system.
   d. Override switch.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.

1. Double-Roller Mounting Configuration: As indicated on Drawings.
C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Solar Shadebands, as indicated on Drawings:
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
      a. Type: exposed with end caps
      b. Color and Finish: as selected by Architect from manufacturer's full range.

F. Room Darkening Shadebands (Single-Fabric), as indication on Drawings:
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
      a. Type: exposed with endcaps and integral light seal where bottom (sill) channels are indicated
      b. Color and Finish: as selected by Architect from manufacturer's full range.

G. Installation Accessories:
   1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
      a. Shape: L-shaped
      b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.
   2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
      a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.
   3. Endcap Covers: To cover exposed endcaps.
   4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 5 inches

b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recesses or pockets and for snap-in attachment to wall clip without fasteners.

a. Closure-Panel Width: as indicated on Drawings.

6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.

8. Installation Accessories Color and Finish: as selected from manufacturer's full range.

1.14 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Transparency of fabric to be 3% open.

1.15 ROLLER-SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.

2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3- EXECUTION

1.16 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1.17 ROLLER-SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

1.18 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

1.19 CLEANING AND PROTECTION

A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

1.20 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work includes, but is not necessarily limited to, the furnishing and installing of all plumbing work, as shown and noted on the Drawings and specified herein. It is not necessarily all inclusive. At completion of work, all systems shall be continuous, operational, and functioning in the proper manner. This section shall be responsible for determining all items and quantities required.

1. Sanitary soil, waste, and vent piping system, including indirect waste piping, and final connections to the on-site waste system.

2. Lab waste and lab waste vent piping system, including connections to pH monitoring and sampling system, and final connections to on-site sanitary sewer.

3. Storm drainage piping system, including rainwater leaders and insulation, overflow drains, final connections to roof drains and overflow drains, and to on-site storm drainage system.

4. Sub-soil foundation drainage piping system, including connections to building and on-site storm drainage systems.

5. Domestic cold water piping system, including connections to plumbing, HVAC, and laboratory fixtures and equipment, and final connections to the on-site cold water piping.

6. Domestic hot water and hot water return piping system, including piping insulation, site distribution piping, connections to plumbing and laboratory fixtures and equipment.

7. Domestic tepid water piping system, including temperature mixing valve and connections to plumbing and laboratory fixtures and equipment.

8. Industrial cold water piping system, including connections to plumbing and laboratory fixtures and equipment.

9. Lab compressed air piping system, including connections to laboratory fixtures and equipment.

10. Lab vacuum piping system, including vacuum exhaust vent, and connections to laboratory fixtures and equipment.

11. Purified water piping system, including and connections to plumbing and laboratory fixtures and equipment.

12. Natural gas piping from downstream of gas meter assembly, including main seismic gas automatic shut-off valve, isolation valves, and final connections to equipment.

13. Coordinate electrical requirements for this work with electrical section.
14. Coordination between this Section and architectural, structural, and civil work.
15. Pipe hanger and support devices, and seismic bracing of piping and equipment.
16. Pressure testing of installed piping and existing portions.
17. Cleaning and flushing of all piping systems.
18. Sterilization of potable cold and hot water piping systems.
19. Sanitization of DI-RO water piping system.
20. Furnish and install all metal fabrications required for piping and equipment supports.
21. All rigging, hoisting, transportation, and associated work necessary for placement of all equipment in the final location shown.
22. Recycled Water system, including piping rough-ins and final connections to water closets and urinals.

B. Related Work Specified Elsewhere
1. Division 01 – General Requirements
2. Division 03 – Concrete
3. Section 220000 – Plumbing
4. Section 222000 – Plumbing Specialties
5. Section 223000 – Plumbing Equipment
6. Section 224000 – Plumbing Fixtures
7. Division 23 – HVAC
8. Division 26 – Electrical
9. Division 31 – Earthwork
10. Division 33 – Utilities

1.2 CODES AND STANDARDS
A. As specified in Section 220000.

1.3 GENERAL REQUIREMENTS
A. As specified in Section 220000 and as follows.
B. All materials, including but not limited to pipes, fittings, valves, etc., installed for potable water system for human consumption shall be lead-free, in accordance with Safe Drinking Water Act, Proposition 65, and NSF 61G.
C. Solution used for system disinfection and sterilization shall be discharged in an approved manner per local ordinances and EH&S requirements. Contractor shall be responsible for managing, storing, and removing discharged solution to an approved hazardous waste management station off-site.

1.4 ELECTRICAL REQUIREMENTS
A. As specified in Section 220000.

1.5 SCHEDULING AND SEQUENCING
A. As specified in Section 220000.

1.6 SUBMITTALS
A. As specified in Section 220000.
B. Product Data:
   1. Submit the following manufacturers' product data for review:
   2. Piping, fittings, and valves.
   3. Circulating pumps.
C. Sterilization and sanitization procedures.

1.7 MATERIALS
A. As specified in Section 220000.

1.8 OPERATION AND MAINTENANCE DATA MANUALS
A. As specified in Section 220000.

1.9 DELIVERY, STORAGE, AND HANDLING
A. As specified in Section 220000 and as follows.
B. Materials are not listed for potable water use shall be store separately from materials for potable water system.
C. “Specially cleaned” materials shall be clearly identified and stored in a separate location, and shall be protected from being contaminated. Any “clean” materials and components that are contaminated or suspected of being contaminated must be re-cleaned in accordance with CGA 4.1.
D. Protect all piping from entrance of foreign materials with temporary caps, or covering. Complete all sections of piping, or cap at end of shift. Maintain all temporary piping end caps until next connection of piping or completion of rough-in and connect.
E. Provide temporary protective coating on steel and cast iron valves.

1.10 TESTING AND SYSTEM ACCEPTANCE

A. As specified in Section 220000.

1.11 WARRANTY

A. As specified in Section 220000.

1.12 QUALITY ASSURANCE

A. As specified in Section 220000 and as follows.

B. Installation of flange gaskets shall be in strict conformance to the gasket manufacturer's recommendations including bolt pattern and torquing requirements.

C. All valves shall have ratings stamped on the valve bodies.

D. All valves shall be full-port, unless otherwise herein specified.

E. All pipes shall be marked with the names or trademarks of the manufacturers and type of pipes.

F. Cleaning, passivation, and/or disinfection of systems shall be performed by company that is qualified and regularly engaged in sterilization work.

PART 2 - PRODUCTS

2.1 MATERIALS OF CONSTRUCTION

A. As specified in Section 220000 and Section 230500.

2.2 DRAINAGE PIPING AND FITTINGS

A. Sanitary Drainage Piping and Fittings:

1. Cast Iron Soil Pipe and Fittings: CISPI 301 or ASTM A-888 standard weight hubless soil pipe and fitting. All pipe and fittings shall be marked with CISPI's collective trademark or receive prior approval be the engineer of record. Joints for hubless pipe and fittings: CISPI 301 and shall conform to the manufacturer's installation instructions and local code requirements. Anaco “Husky SD 4000, Clamp-All 125, Tyler WB, MG Couplings, or equal, comply with FM 1680, Class 1.

2. Copper Vent Piping and Fitting (Above floor): ASTM B306 DWV type copper tubing and ANSI B16.23A cast bronze solder-joint drainage type fitting. Provide Mission, or equal, CISPI 310 adaptor coupling with neoprene gasket and stainless steel shield with two bands. Use only as permitted by local ordinances.
3. Condensate Drainage Piping and Fittings
   a. ASTM B88 hard drawn deoxidized, Type M copper tubing with wrought copper wyes and long radius fittings.

B. Lab Waste and Vent Piping and Fittings:
   1. Lab Waste and Vent Piping (Above Floor): Chlorinated Polyvinyl Chloride (CPVC) piping and fitting, similar to that for below slab installation.
   2. Use mechanical joints at equipment, and lab sink rough-ins.
   3. Provide supports spaced per pipe manufacturer’s instructions and recommendations.
   4. Provide adapters for connecting plastic piping to stainless steel piping.
   5. Use stainless steel piping for exposed to sunlight installations, such as vents through roof.

2.3 PRESSURE PIPING AND FITTINGS

A. Copper tubing for water service: Hard drawn deoxidized water service tubing conforming to ASTM B88, Type “L” and Type “K” as specified herein.


C. Flanges for Copper Tubing: ASME B16.24 cast copper alloy.

D. Soft Copper Tubing: Soft Annealed ASTM B88, Type "K" tubing, and ANSI B16.22 fitting.

E. Threaded to Solder Adaptors: As specified for solder type fittings.

F. Solder: Harris, Engelhard, or equal, ASTM B32 lead-free solder for all water piping.

G. Harris, Engelhard, or equal, BCuP filler material for brazing of copper fitting joints.

H. Steel Pipe: ASTM A53, Schedule 40 black steel or galvanized piping.


K. Purified Water Piping and Fittings:
   1. George Fisher, Charlotte, IPEX, or equal, Schedule 80 CPVC, Type IV, Grade I, chlorinated polyvinyl chloride compound with a cell class of 23448 per ASTM D1784, conforming to ASTM F441. ASTM F439 fittings with solvent cement socket joints conforming to ASTM F493. Flanges shall conform to ASME B16.5 Class 150.
L. Vacuum Piping and Fittings:

M. Underground Domestic Hot Water Piping and Fittings:
   1. Perma Pipe Ricwil Copper-grad, or equal, integral sealed double wall copper piping system with rigid polyurethane foam covered with PVC outer jacket and factory applied vapor barrier on the ends of the insulation.
      a. Inner Carrier: ASTM B88 Type K copper tubing.
      b. Insulation: 2” thick Polyurethane foam shall be rigid, closed-cell with a thermal conductivity ratio of 0.14 BTUH Sq. Ft. °F/in. at 73 °F, and completely fill the annular space between the carrier and the secondary protective jacket. Ends shall be sealed with a moisture barrier capable of withstanding 20 ft. head pressure.
      c. Outer Jacket: Type I Grade I polyvinyl chloride (PVC) pipe with a minimum wall thickness of 0.060 inches.
      d. Joints: O-ring sealed couplings with insulation, jacket, and sealed ends.
      e. Fittings: ANSI B16.22 wrought copper fittings with brazed joints.
      f. Double wall copper system shall be approved by NSF.

N. Natural Gas Piping and Fitting:
   1. Below Grade Piping: PE 2406, polyethylene piping conforming with ASTM D 2513, with socket type fittings conforming with ASTM D 2683, and minimum SDR 11. For 6" size natural gas main, use butt fittings with SDR 11. Provide polyethylene to Sch. 40 steel pipe transition fitting and riser at each building prior to extending gas piping above ground. Provide 16 AWG copper trace wire over entire run of PE piping at 12 inches above pipe.

O. Recycled Water: Piping and fitting are same as for domestic cold water piping system above. Piping shall be wrapped with purple color (Pantone color #512) mylar tape or paint in purple (Pantone color #512) with pipe label reading: “CAUTION: RECYCLED WATER, DO NOT DRINK.”

2.4 VALVES

A. Water Valves for Potable Water Systems: In compliance with Section 1417 of SDWA, and NSF-61G Standards.

2. Butterfly Valves, 2-1/2" and larger: Watts DBF-03, Nibco LD-2020-3-LF, Danfoss Flomatic, or equal, ductile iron, lug style body, with molded-in EPDM liner, stainless steel disc, extended neck, and lever-lock handle, 200 PSI.

B. Water Valves for Industrial/Process Water Systems:
   1. Ball Valves, 2" Size and Under: T-585-70, BA-400, threaded, 600 PSI WOG, 150 PSI, two-piece bronze body with bronze trim and full port chrome-plated ball.

C. Purified Water System:
   1. All valves shall be compatible with the specified piping material.
   2. Asahi Type 14, IPEX VM, CPVC true union ends, CPVC body and polypropylene (PP) bonnet, EPDM diaphragm, PP wheel handle, position indicator on top, 150 PSI rated. Use for sizes 2" and smaller.
   3. George Fisher Type 317, Asahi Type 14, IPEX VM, CPVC flange ends, CPVC body and polypropylene (PP) bonnet, EPDM diaphragm, PP wheel handle, position indicator on top, 150 PSI rated. Use for 2-1/2" sizes and up to 4" size.

D. Lab Vacuum System:
   1. Milwaukee BA475B, or equal, UL Listed, CSA and FM approved, two-piece brass body ball valve, brass chromeplated ball with brass trim, PTFE seat, threaded ends, 600 PSI WOG, and 29" Hg vacuum service.

E. Natural Gas System:
   1. For 2" and smaller sizes: Nibco T-FP-600N, Milwaukee BA-475B, or equal, 2-piece full-port brass ball valve with threaded ends, rated for 600 PSI, UL listed, CSA approved, ASME B16.44, CR91-002, and FM approved.
   2. For 2-1/2" and larger sizes: Homestead 602, Nordstrom 115, or equal, lubricated plug valve with cast iron body and plug, flanged ends, rated for 200 PSI, UL listed and CSA approved.

2.5 SEISMIC SHUT-OFF VALVES:

A. California (KOSO) Valves, Safe T Quake, or equal, automatic gas shut-off valve with aluminum body, self-operated shut-off actuation, and manual reset, rated for a maximum working pressure of 60 PSI, UL listed.

2.6 CHECK VALVES

A. Potable Water Systems: In compliance with Section 1417 of SDWA, and NSF-61G Standards
1. For 2" size and smaller: Nibco T-413-Y-LF, Red and White Model 236, Kitz Model 822T, or equal, Y-Pattern swing check, bronze body and bronze trim, threaded ends, Class 125, 200 PSI WOG.

2. For 2-1/2" size and above: Mueller 105MAP, Danfoss Flomatic, or equal, spring-loaded lift disc check, globe body with cast iron construction and bronze trim, flange ends, Class 125, 200 PSI WOG, and rated at 150°F.

B. Industrial Water Systems:

1. Nibco T-413, Red & White Model 236, Kitz Model 22T, or equal, Y-Pattern swing check, bronze body and bronze trim, threaded ends, Class 125, 200 PSI WOG.

2. Nibco, Red & White, Kitz, Milwaukee, or equal, F-918-B, Model 435, Model 78, F-2974A, horizontal swing check, bolted bonnet, renewable seat and disc, cast bronze disc, cast iron body, flange ends, Class 125, 200 PSI WOG.

C. Purified Water System:

1. Asahi, Hayward, or equal, polypropylene body conforming to ASTM D4101 with ANSI flange ends, swing type with EPDM seat, 100 PSI rated for sizes 3/4" to 3" sizes.

D. Lab Vacuum Systems:

1. Powell Fig. 563, Nibco T-473, Crane, or equal, threaded ends, Y-pattern swing check, bronze body and bronze trim with PTFE disc insert, Class 300, 600 PSI WOG, cleaned for oxygen service conforming to CGA G4.1.

2. Powell Fig. 7K0126, or equal, tubing ends, lift disc check, bronze body and bronze trim with PTFE disc insert, Class 300, 600 PSI WOG, cleaned for oxygen service conforming to CGA G4.1. Use for cryogenic services.

3. Nibco F-960-W, Crane, or equal, flanged ends, wafer disc check, cast iron body and Buna-N bonded bronze seat, Class 250, 400 PSI WOG, cleaned for oxygen service conforming to CGA G4.1. Use for 4" and larger sizes.

2.7 CIRCUIT BALANCING VALVES

A. Industrial Water Systems:

1. Bell & Gossett “Circuit-Setter Plus”, Nibco T1710, Griswold, or equal, bronze body, two metering / test ports with integral checks and caps, position memory stop and calibrated name plate, and threaded ends, 300 PSIG WOG and 250°F rated.

2.8 UNIONS AND DIELECTRIC FITTINGS

A. Unions for Steel Pipe:

1. 2" size and smaller: Malleable iron, ground joint pattern, brass to iron seat, female threaded-end connections, 150 PSI.
2. **2-1/2” size and larger**: Standard 150 PSI flanges with gaskets and bolts.

B. **Unions for Copper Tubing**: Solder joint ends, cast bronze, ASTM B62 and ANSI B16.18.

C. **Copper to Ferrous Connections**: Epco, Vallet, or Ecoff dielectric pipe unions, threaded or flanged as required with gaskets rated at 250 PSIG.

2.9 **UNDERGROUND METALLIC PIPING**

A. As specified in Section 220000.

2.10 **PIPING SUPPORTS AND ANCHORS**

A. As specified in Section 220000 and Section 230519.

2.11 **INSULATION**

A. As specified in Section 220000.

2.12 **SLEEVES**

A. As specified in Section 220000.

2.13 **STENCILING, IDENTIFICATION, AND COLOR CODING OF PIPES**

A. As specified in Section 220000.

2.14 **ESCUTCHEON PLATES**

A. As specified in Section 220000.

2.15 **CORROSION PROTECTION**

A. As specified in Section 220000.

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**PART 3 - EXECUTION**

3.1 **GENERAL**

A. See Section 220000, Section 230500, and as follows.


D. Lab Waste and Lab Vent piping systems shall be sized and installed in accordance with latest edition of California Plumbing Code, similar to Sanitary Sewer and Vent.
E. Sub-surface Storm Drainage mains shall be solid piping and drain gravity to onsite system by civil engineers.

F. Gas piping shall be sized and installed in accordance with California Plumbing Code and NFPA 54.

G. Check all piping runs before hand with all other trades. Run piping to maintain proper clearance for maintenance and to clear opening in exposed areas. Run piping in strict coordination with existing mechanical piping, ducts and equipment, structural and architectural conditions. Piping shall be concealed in designated ceiling spaces, and wall spaces, unless otherwise noted for exposed installation. Where work of other trades prevents installation of the piping as shown on the Drawings, reroute piping at no extra cost. Verify all inverts and pitched lines before starting work.

H. Install all exposed piping parallel to or at right angles with building walls and tight to walls or ceilings wherever possible, except where otherwise shown on the Drawings. Install all piping below the bottom of beam elevations; provide sleeves as required. Install no-hub coupling bands with screws as far back as possible behind pipes.

I. Install all piping free from traps and air pockets and true to line and grade. It is important that all water, deionized water, and lab vacuum piping can be drained by gravity.

J. Where exposed pipes pass through furred walls and suspended ceiling, fit in all finished rooms and conspicuous locations with escutcheon plates. Escutcheon plates must be securely held in position allowing enough clearance to care for expansion and shall be sufficient size to cover the opening around the pipe.

K. Support all pipe from the building structure so that there is no apparent deflection in pipe runs. Piping or equipment shall be immobile and shall not be supported or hung by wire, rope, plumber's tape or blocking of any kind. Do not support piping from ducts, other pipes, conduit, or any materials except building structure.

L. Piping support spacing shall comply with CPC Tables 3-2 and 12-3, and as noted in table below. Bracing and seismic restraints shall be per CBC and as specified in Section 230529. Hanger rods and spacing shall be as follows, at minimum:

<table>
<thead>
<tr>
<th>Pipe Size (Inches)</th>
<th>Min. Rod Size (Inches)</th>
<th>Copper Tubing (Feet)</th>
<th>Hubless Cast Iron Pipe (Feet)</th>
<th>Steel Pipe (Feet)</th>
<th>Plastic Pipe (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; Smaller</td>
<td>3/8</td>
<td>5</td>
<td>--</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>1-1/4</td>
<td>3/8</td>
<td>6</td>
<td>--</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>1-1/2 to 2</td>
<td>3/8</td>
<td>6</td>
<td>**</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>2-1/2 to 3</td>
<td>1/2</td>
<td>10</td>
<td>**</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>4 - 6</td>
<td>5/8</td>
<td>10</td>
<td>**</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

*Each branch of piping over 3 feet long shall have a separate hanger.

** Every other joint, unless over 4 feet, then support each joint.
M. Insulate where copper tubing comes in contact with ferrous material with double wrapped heavy vinyl tape.

N. No valve and no piece of equipment or trim shall support the weight of any pipe. Support piping independently at pumps and the like so that its weight will not be supported by the equipment.

O. Install all valves, vents, traps, cleanouts and other trim in accessible locations.

P. Make all changes in direction with fittings, unless otherwise herein specified.

Q. Wherever changes in sizes of piping occur, make such changes with reduced fittings, as the use of face bushings will not in general be permitted. Install eccentric reducing fittings where necessary to provide free drainage of lines.

R. Unless otherwise noted, install water supply and return piping with straight side of eccentric fittings at top of pipe.

S. Provide sufficient swing joints, seismic joints, expansion loops and devices necessary for a flexible piping system.

T. Install a union on downstream side of threaded-end valves, cocks, equipment and at other points where required for disassembly or where shown.

U. Furnish and install insulating unions or insulating flanges as hereinbefore specified at all connections of ferrous and nonferrous piping. Insulating devices shall completely isolate metal-to-metal contacts between dissimilar metals.

V. Unless otherwise noted, provide threaded joints on steel piping 2 inches and smaller, and welded joints on black steel piping 2-1/2 inches and larger.

W. In general, on welded piping, branch take-offs from pipe mains to be made with standard welding tees. Weldolet type reinforced branch connection fittings may be used on all branch take-offs 6 inches and smaller and if the size of the branch pipe is at least three standard pipe sized smaller than the size of main pipe.

X. Close all openings in pipes with appropriate caps, plugs, or covers during progress of the Work to preclude introduction of undesirable materials.

Y. At completion of work, no piping exhibiting rust will be accepted.

Z. Where any lab waste pipe is inside electrical rooms, provide double contained pipe with secondary piped to an indirect waste receptor.

3.2 SANITARY WASTE AND VENT, AND STORM DRAINAGE PIPING

A. Cast iron no-hub soil pipe and fittings.

B. All sanitary waste piping from urinals shall be cast iron piping and fittings.
C. Sanitary vent piping above grade shall be cast iron piping with hubless fittings and standard stainless steel and neoprene gasket coupling. DWV copper may be used only as permitted by Code.

3.3 LAB WASTE AND VENT PIPING

A. Lab Waste: Schedule 80 CPVC piping with solvent cement joints.

B. Lab Waste Vent: Schedule 40 CPVC piping with solvent cement joints.

C. All underground lab waste and vent installation shall be performed per manufacturer’s recommendations. Manufacturer’s representative shall be responsible to instruct and train the installers for proper installation.

D. Provide flanges and/or threaded adaptor for connecting dissimilar materials. Installation shall be per manufacturer’s recommendations.

E. Lab waste and vent piping installed outdoor and exposed to sunlight shall be stainless steel.

3.4 HOT, COLD, AND TEPID WATER PIPING

A. Above Grade: Type “L” copper tubing with wrought copper solder-joint fittings.
   1. For 2” size and smaller: Lead-free soldered joints.
   2. For 2-1/2” size and larger: Silver-brazed joints.

B. Below Grade: Type “K” soft annealed copper tubing with bended long radius elbows and no joints.
   1. Piping shall be encased in 8 mil thick polyethylene sleeves, with ends sealed.

C. Outside Underground except domestic hot water: Type “K” copper tubing with wrought copper solder-joint fittings. All joints shall be silver brazed.
   1. Piping shall be encased in 8 mil thick polyethylene sleeves, with ends sealed.

D. Outside Underground for domestic hot water:
   1. Double wall copper system with PVC jacket.
   2. Installation shall be per manufacturer’s recommendation.
   3. Provide concrete thrust blocks prior to testing pipe at every change of direction after the joints are tested. Thrust blocks shall be sized per manufacturer’s recommendation.

E. Provide dielectric unions for all connections between ferrous and copper piping.
3.5 SANITARY SOIL, WASTE, VENT, HOT AND COLD WATER BRANCH PIPING SIZES

A. See Fixture Schedule on drawing for connection sizes.

B. Drainage piping and Vent piping systems shall be installed in accordance with California Plumbing Code.

C. Do not run 1” size for flushometers longer than 3'-0", then increase to 1-1/4" size.

D. 1/2” horizontal suspended branch lines shall not be longer than 5'-0”.

3.6 PURIFIED WATER PIPING

A. Schedule 80 CPVC piping with solvent cement joint fittings.

B. All open ends of piping must be capped until piping is ready for new connections.

C. All piping and fitting must be factory sterilized and capped or packaged immediately after production.

D. All tools used for purified water pipe installation shall be clean and kept separate from other tools and used exclusively for DI-RO Water piping.

E. Cut pipe with wheel-type plastic cutter only. Each cut shall be deburred with the pipe piece oriented vertically with the end to be deburred pointing downward. After pipe is cut, deburred and chamfered, clean the disturbed external end.

F. Installation shall be per manufacturer’s recommendations.

G. Threaded joints shall be used only at equipment connections. All threaded joints shall be made with Teflon, or Bestolife tape.

H. Piping shall be installed for self-draining. Provide 3/4” size valves at all system low points for draining.

I. Provide continuous channel supports for DI water distribution.

J. Where indicated, deadlegs shall be kept at minimum and shall not exceed 6 pipe diameters.

3.7 LAB VACUUM PIPING

A. Type L copper piping and wrought copper fitting.

B. Vacuum piping fittings shall be long sweep elbows, and joints shall be made with 95-5 tin-antimony solder.
C. Install a minimum of threaded joints. Teflon thread tape shall be used where threaded joints are indicated or required. Factory-threaded fitting shall only be used in these applications.

D. Vacuum piping branches shall take off from top of main at 45 degrees.

3.8 NATURAL GAS PIPING

A. Materials supplied and installed in this Section shall be installed in accordance with NFPA 54 and California Plumbing Code.

B. Branch take-offs from welded system pipe mains shall be made with standard welding tees. Weldolet type reinforced branch connection fittings may be used on branch take-offs for 6” and smaller sizes when the size of the branch pipe is at least three standard pipe sizes smaller than the size of the main pipe.

C. Tracer wire shall be minimum #18 AWG wire with yellow jacket and attached to underground non-metallic piping. One end shall be brought aboveground at a building wall or riser.

D. Provide 6” dirt legs and flexible connectors at all appliance and equipment connections.

E. Plug all drains and by-pass valves.

F. Installation shall be per manufacturer’s recommendations.

G. Above Grade:
   1. For 2” and smaller sizes: Steel pipe with malleable iron threaded fittings.
   2. For 2-1/2” and larger sizes: Steel pipe with butt welded steel fittings per AWS D1.1.
   3. Piping and fittings exposed to weather shall be galvanized. Field apply galvanize coating for all field cut joints. Paint all exterior and exposed piping to prevent rust.
   4. Where piping is in concealed space, unions, couplings, bushings, and swing joints shall not be used.
   5. Piping shall not be used for grounding. Where piping system is considered to become energized, each section shall be electrically continuous and bonded to a ground-fault current path.

H. Below Grade:
   1. Site distribution
      a. Polyethylene gas pipe with heat fusion or electro-fusion butt welded fittings.
      b. Provide anodeless riser at material transition.
2. Within 5 feet outside of the building
   a. Coated steel pipe with butt welded steel fittings per AWS D1.1.
   b. Wrap pipe and fittings with AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
   c. Coal Tar Enamel Coating: Exterior of pipe and fittings shall be cleaned, primed with Type B primer and coated with hot-applied coal tar enamel with bonded layer of felt wrap in accordance with AWWA C203. Asbestos felt shall not be used. Felt material shall be fibrous glass mat as specified in Appendix A2.1 of AWWA C203.

3.9 SEISMIC SHUT-OFF VALVES
   A. Installation shall conform to ANSI Z21.70.

3.10 INSULATION
   A. As specified in Section 220000.

3.11 SLEEVES
   A. As specified in Section 220000.

3.12 CORROSION PROTECTION
   A. As specified in Section 220000.

3.13 ESCUTCHEON PLATES
   A. As specified in Section 220000.

3.14 LUBRICATION
   A. As specified in Section 220000.

3.15 EXCAVATING, TRENCHING AND BACKFILLING
   A. As specified in Section 220000.

3.16 STENCILING AND IDENTIFICATION
   A. As specified in Section 220000.

3.17 VALVE TAGS
   A. As specified in Section 220000.
3.18 CLEANING

A. As specified in Section 220000 and as follows.

B. All field cut pipe ends shall be squared and reamed to full bore of piping to remove all burrs and chips. Follow the installation instruction for each fitting manufacturer when assemble joints.

C. Thoroughly clean, flush, and drain all drainage and water piping systems of any nature of piping contaminants such as cuttings, filings, lubrication, rust, scale, grease, solder, flux, debris with clean water prior to testing.

D. Lab vacuum piping systems shall be blown free of piping contaminants with clean, dry oil-free compressed air at 125 PSI.

E. Cleaning of Lab Compressed Air Systems:
   1. Cleaning procedures shall be per CGA G-4.1:
      a. Piping and fittings shall be thoroughly washed by the manufacturer in a hot solution of trisodium phosphate (170° to 180°F during entire wash period) mixed in ration of 1 pound per 3 gallons of water. The use of organic solvents such as carbon tetrachloride is prohibited. After washing, rinse thoroughly with clean hot water.
      b. After cleaning, all tubing and fittings shall be capped or plugged, and all valves shall be packed in special packing suitable for use with medical gas piping systems.
      c. Exercise care in handling equipment and tools used in cutting or reaming of pipe to prevent oil or grease being introduced into the piping system. Where such contamination has occurred, items affected must be rewashed per above.
   2. Prior to testing, piping shall be blown clean of piping contaminants with dry nitrogen gas.
   3. Submit a certificate for system cleanliness verification per NFPA 99C.
   4. System shall be charged with dry, oil-free nitrogen gas until placed in service.

F. Cleaning and Sanitization of Purified Water System:
   1. General:
      a. Evoqua Water Technologies, Bennett Marine Utility, Inc, or equal
      b. Submit a preliminary copy of sanitization procedures for Owner’s review. Test shall not be started prior to an approval from the Owner’s Representative.
      c. Sanitize system after testing is completed.
d. All pipe, fittings, valves, and system-related materials shall be cleaned before use.

e. This Section shall furnish and install all valves, outlets, and devices required by the Sub-Contractor to complete the sanitization work.

f. Upon a satisfactory completion of all sanitization procedures, Contractor shall submit a certificate of acceptance to the Owner.

2. Requirements:

a. Alconox detergent and 30% hydrogen peroxide cleaning agents.

b. Circulating pump.

c. Acid resistant tanks of sufficient size to fill all lines.

d. 1% potassium permanganate testing solution.

e. Balsbough resistivity meter.

3. Cleaning Procedure:

a. Flush piping system with ASTM D1193 Type II water to remove all foreign substances.

b. Connect piping systems to be cleaned to the pump and tank. Fill the tank with Type II water and add Alconox 25 grams/gallon.

c. Circulate solution through all piping for 6 hours at a velocity of 3 FPS, bleeding 0.5 gallons from each valve at 2 hour intervals.

d. Drain system and refill with Type II water and test resistivity. Repeat procedure until the return side of each loop conforms to the Type II water specifications.

e. Add hydrogen peroxide (1 gallon per 5 gallons of system volume) and repeat Procedure c and d.

f. Flush system with fresh Type II water and test all discharge points with potassium permanganate. Continue flushing until test shows negative. (A positive test will show color change from violet to brown.)

g. Drain and fill system including the installation of filters in filter housings, pumps, and storage tanks with Type I water and proceed to operate entire system.

h. Test water quality and continue flushing with Type I water until the return side of each loop matches that of the flushing water.

G. Cleaning of natural gas piping

1. Natural gas piping systems shall be blown free of piping contaminants with clean, dry, and oil-free compressed air at 125 PSI. For system components with a maximum pressure rating less than 125 PSI, components shall be blocked off during the 125-PSI air cleaning and shall be cleaned with clean, dry, and oil-free compressed air at the individual component maximum rated pressure.
3.19 VALVE INSTALLATION

A. As specified in Section 230500 and as follows.

B. Valve handles of piping in concealed ceiling spaces shall be installed in horizontal position such that handles clear ceiling tiles. No valve handles shall be installed below the horizontal axis of the valve.

C. All drain valves shall be located above accessible areas.

3.20 ADJUSTMENT

A. Check valve positions to ensure all on-off valves are either completely open or completely close.

B. Lock all balancing valves in position after system balancing is complete.

C. Set natural gas pressure regulator valves at 11” W.C., unless otherwise noted on plans.

3.21 TESTING

A. Before conducting tests, valve-off or disconnect any equipment and apparatus which may be damaged by the test pressures higher than normal working pressures.

B. All testing shall be witnessed and approved by the Owner's Representative and local authority.

C. Underground Piping:
   1. Test shall be conducted after backfilling prior to the concrete slab formwork to ensure the integrity of the underground pipe network.
   2. Double wall copper system: All joints shall be hydrostatically tested prior to pouring thrust blocks.

D. Sanitary Waste and Vent Piping: Test and prove tight with 10 feet head of water, in accordance with the California Plumbing Code.

E. Lab Waste and Vent Piping shall be tested the same as for sanitary waste and vent piping.

F. Storm Drainage Piping shall be tested the same as for sanitary waste and vent piping.

G. Hot and Cold Water: Test and prove tight hydrostatically at a pressure of 150 PSI.

H. Purified Water piping: Perform a two-stage test with ASTM D1193 Type II water.
   1. 1st-stage Test: Entire system, including but not limited to piping, valves, and faucets, shall be tested and proven tight hydrostatically at 100 PSI for duration of 4 hours.
2. **2nd-stage Test:** After 1st-stage test is proven acceptable, test and prove the distribution system including piping and valves tight hydrostatically at 150 PSI for duration of 4 hours.

3. After testing is approved, drain and sterilize the system.

I. Vacuum piping: Test with dry, oil-free compressed air at 100 PSI, and at 26" Hg vacuum.

J. Final pressures at the end of test period shall be not more than that caused by expansion or contraction of the test medium due to the temperature changes.

K. Apply tests for a minimum period of two (2) hours, or as noted above, or until tests are complete, in the opinion of the inspecting authority.

L. Work may be tested in sections, if necessary, for convenience. In this case, test of last section shall include all connection between previously tested sections and section under test.

M. Furnish all labor and all other utilities required to make tests. Install pressure gauges as required for test.

N. When the various systems are completed, run operation tests to demonstrate proper operating conditions. Run these tests under the observation of the Owner’s Representative. Operate the water systems through all cycles of operation for this period of 8 hours. Instruct the Owner’s operators during this period. Perform operations tests under actual service conditions.

O. Should any piece of equipment, apparatus, material, or work fail in any of these tests, immediately remove and replace by perfect material, and re-test the portion of the work replaced.

P. Low pressure natural gas (less than and equal to 14" W.C.): gas piping shall be tested with dry, oil-free, compressed air at 15 PSI, in accordance with California Plumbing Code, and NFPA 54.

1. Apply tests for a minimum period of two (2) hours, or as noted above, or until tests are complete, in the opinion of the inspecting authority.

2. Obtain a certificate of inspection from the Authority Having Jurisdiction prior to system start-up.

3.22 **DISINFECTION OF POTABLE WATER SYSTEMS**

A. Bennett Marine Utility, Inc, Water Chemists, or equal.

B. At completion of the testing and adjusting and before potable water systems are put into use, they shall be sterilized in accordance with the current edition of AWWA C651 and the procedures specified below.
1. Chlorination Method:
   a. Fill systems with potable water and chlorine at a rate to maintain a minimum chlorine concentration of 50 ppm in the entire systems. Retain solution in systems for 24 hours. Cycle all valves during this period.
   b. Test for the residual concentration in systems at the end of 24 hours. A minimum concentration of 50 ppm of chlorine is required at all chosen sampling points.
   c. After approval to proceed, flush systems with potable water to remove the chlorine solution until the chlorine level in the discharge water is the same as that of the flushing water.

2. Bacteriologic Test:
   a. After flushing is complete, fill systems with potable water. Samples of water shall be taken 3 days after the systems are re-filled and to a certified laboratory for qualitative and quantitative bacteriologic analysis. Bacteriologic analysis must include Coliform bacteria test.
   b. The system shall remain out of service until the results of the bacteriologic tests are approved.

C. Submit a preliminary copy of disinfection procedures for Owner’s review. Test shall not be started prior to an approval from the Owner’s Representative.

D. Until sterilization of the water system has been made, provide signage at all water outlet locations stating the water system has not been sterilized and shall not be used for human consumption.

E. This Section shall furnish and install all valves, outlets, and devices required by the sterilization Sub-Contractor to complete the disinfection work.

F. Upon a satisfactory completion of all sterilization procedures, Contractor shall submit a copy of the disinfection report, bacteriologic test report, and a certificate of acceptance to the Owner.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The scope of work covered by these specifications includes the complete installation of all mechanical HVAC (Division 23), Plumbing (Division 22), and Fire Protection (Division 21) work for this project. The scope includes furnishing all drawings, specifications, calculations, design, equipment, material and labor necessary for complete and operable systems, including General Conditions and Division 1.

1.2 RELATED SECTIONS

A. Section 019113 - General Commissioning Requirements
B. Section 211000 - Water-Based Fire Suppression Systems
C. Section 220000 - Plumbing
D. Section 221000 - Plumbing Piping and Valves
E. Section 222000 - Plumbing Specialties
F. Section 223000 - Plumbing Equipment
G. Section 224000 - Plumbing Fixtures
H. Section 230513 - Common Motor and Drive Requirements for HVAC Equipment
I. Section 230529 - Hangers, Supports, and Seismic Restraints for Mechanical Equipment
J. Section 230548 - Vibration Controls for Mechanical Piping and Equipment
K. Section 230590 - Testing for HVAC
L. Section 230593 - Balancing for HVAC
M. Section 230700 - Insulation
N. Section 230901 - Laboratory Control System
O. Section 232113 - Hydronic Piping and Valves
P. Section 232114 - Hydronic Systems for HVAC
Q. Section 232115 - Chemical (Water) Treatment
R. Section 232123 - Hydronic Pumps
S. Section 232202 - Heating Hot Water Boilers
T. Section 232204 - Boiler Flues and Accessories
U. Section 232420 - Air-Cooled Electrical Chiller
V. Section 232900 - Variable Frequency Drives
W. Section 233000 - HVAC Air Distribution
X. Section 233400 - HVAC Fans
Y. Section 233600 - Air Terminal Units
Z. Section 237300 - Air Handling Units
AA. Section 237305 – Split Air Conditioning VRV System
BB. Section 250000 - Building Automation System

1.3 DESCRIPTION OF WORK

A. The work includes but is not necessarily limited to the following general headings:

1. Provision of all mechanical HVAC, plumbing, and fire protection systems for work of this project.
   a. Shop drawings and submittals.
2. Coordination and coordination drawings.
3. Record as-built documents.
4. Operations and maintenance manuals.
5. Equipment and systems training for Owner’s personnel.
6. Testing and Balancing
7. Commissioning.
8. Determine all items and quantities required.
9. Provide complete, continuous, operational, and functioning systems.
10. Fully coordinate with work of other Sections, including field verification of elevations, dimensions, clearance, and access.
11. Repair of all damage done to premises as a result of this installation and removal of all debris left by those engaged in this installation.
12. All rigging, hoisting, transportation, and associated work necessary for placement of all equipment in the final location shown.
13. Disassembly and re-assembly of any equipment furnished under this Section, should this be required in order to move equipment into final location shown on the Drawings.

14. All labor, materials, tools, appliances and equipment that are required to furnish and install the complete installation for this Section of the work including that which is reasonably inferred.

15. Cooperation with other crafts in putting the installation in place at a time when space required is accessible.

16. Temporary scaffolding necessary for performance of the work in Divisions 21, 22, and 23.

17. Cutting and core drilling required for work of Divisions 21, 22, and 23, including locating of rebar or coordination of locating rebar with the Contractor.

18. Cutting, drilling, notching for installed systems.

19. Pipe sleeves for all holes in walls, floors, and ceilings, and cutting of floor slabs and slabs on grade.

20. Waterproofing where necessary for installation under Divisions 21, 22, and 23.

21. Cooperation with and assistance to the Building Automation System Contractor as required to provide a complete and functional HVAC control system.

22. Counterflashing of roof penetration for work of Divisions 21, 22, and 23.

23. Sizes, and locations for installation of concrete curbs and pads for work of Divisions 21, 22, and 23.

24. Temporary and permanent stands, supports, and bases for equipment requiring them, including vibration isolation.

25. Temporary protection of existing installation.

26. Firestopping of penetrations of ducts, piping and conduits through walls, floors, and ceiling assemblies.

27. Temporary utilities as required to install work on Divisions 21, 22, and 23 including lighting, water, gas, electricity, etc.

28. Stenciling and equipment identification.

29. Fees, permits, inspections, taxes, and approach from agencies that have jurisdiction over installation of Divisions 21, 22, and 23.

30. See subsequent Sections for detailed descriptions.

31. See Section 23 09 01, 1.1.F for additional bid requirements for laboratory control system.
1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Codes: Provide work in accordance with appropriate standards, codes, and recommendations, including those of the following agencies:

1. 2016 California Building Code
2. 2016 California Plumbing Code
4. 2016 California Fire Code
5. Latest edition, California Electrical Code
6. 2016 California Energy Efficiency Standards
7. Underwriters Laboratories (UL).
9. CALOSHA.
10. California Code of Regulations (CCR) Title 8, 9, 22, and 24.
11. Foothill College facility standards.
12. City of Los Altos local ordinances.

B. Energy Codes: All equipment, systems, and insulation installed in Divisions 21, 22, and 23 shall comply with the minimum requirements of 2008 California Energy Efficiency Standards.

C. Nothing in the Contract Documents shall be construed to permit work not conforming to the applicable laws, ordinances, rules, regulations.

D. When requirements of the Contract Document exceed requirements of applicable laws, ordinances rules, regulations, the requirements of the Contract Documents shall take precedence.

1.5 PERMITS, LICENSES, AND INSPECTIONS

A. Permits: The contractor shall pay for all permits required by work under Divisions 21, 22, and 23.

B. Inspections: All work shall be regularly inspected and certificates of approval shall be delivered to the Owner.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. Submit shop drawings and supplemental data for all materials and equipment providing at a minimum 5 copies or as directed by the Contractor. Submit shop drawings in AutoCad format acceptable to the Owner’s Representative.
1. Shop drawings shall be drawn to a scale of ¼’ = 1’0”, and shall include complete dimensions, elevations, and clearances for all plumbing, piping, ductwork, equipment, and valve numbers.

B. Forward all submittals to the Contractor for the Owner review together, at one time. Individual or incomplete submittals will not be acceptable.

C. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.

D. Identify each substantial item by reference to the specification Section paragraph in which the items specified or drawing and detail number.

E. Organize submittals in the same sequence as they appear in specification Sections, articles or paragraphs.

F. Any mechanical, electrical, structural, or other changes required for the installation of any approved substantial equipment provided as part of the work of Divisions 21, 22, and 23 shall be made to the satisfaction of the Owner and Owner’s Representative at no increase in contract price. Approval by the Owner of the substituted equipment and/or dimensional drawings does not waive these requirements. Submit drawings of equipment spaces showing substituted equipment prior to installation.

G. Approval of equipment shall not be construed as authorizing any deviations from the approved contract documents unless the attention of the Owner and Owner’s Representative has been directed to the specific deviations.

H. Furnish upon request, complete installation instructions on all material and equipment to be provided a part of the Work of Divisions 21, 22, and 23 before commencing installation of same.

1.7 COORDINATION DRAWINGS

A. Individual trade contractors are responsible for developing CADD drawings for the purpose of coordinating all above-ceiling utilities. The coordination effort shall include, but not be limited to, plumbing, electrical conduits, electrical panels, lights, structural, door jamb studs, ceiling hangers, braces, sprinklers, and ceiling miscellaneous steel.

B. Coordination must be performed in 3-dimensional (3D) CADD software using automatic clash detection.

C. Meetings will be held by the General Contractor to coordinate the locations of utilities and resolve conflicts. Each subcontractor will revise the ceiling and wall coordination CADD drawings to show changes in layout. Meetings at the project site, at a minimum will be conducted once every other week, until the AutoCAD coordination drawings have been completed. The MEP and architectural coordination team will meet as needed throughout the project as required by the contractor to coordinate the work. The Owner’s Representative will provide CADD files showing the project backgrounds for use by the contractors in developing the coordination drawings.
1. Use AutoCAD version acceptable to the Project Architect.

2. Coordinate with all other trades and Owner-supplied items.

3. Check routing and elevations of all ductwork, piping, conduit, raceways, etc., and equipment before fabricating.

4. Report conflicts that cannot be solved in the field to the Owner’s Representative.

5. Extra charges shall not be allowed due to lack of coordination prior to, or during, construction.

6. Distribute Drawings to trades that are affected.

7. In addition to plan view, indicate the exact locations and sizes of all conduits, piping, ductwork, equipment, and openings through walls. Indicate heights and clearances from structure and from other trades. Use partial sections where necessary.

8. Provide proper clearances for access to and service of all equipment and items requiring adjustment including shutoff valves, electrical equipment, etc.

9. The coordination Drawings are be reviewed and checked for completeness by the General Contractor.
   a. The coordination drawings need not be submitted for review, but shall be available for examination to discuss coordination issues as they arise.
   b. Any review performed by the Owner’s Representative will only cover design intent.
   c. Responsibility for proper coordination remains with the Contractor.
   d. Ceiling hatches must be clear of obstructions for ease of access.

D. Differences or disputes concerning coordination, interference, or extent of work between trades shall be decided by the General Contractor at no additional cost to the Owner.

E. The Contractor shall prepare a coordination schedule to achieve completed and approved coordination plan prior to installation of each area in accordance with the project schedule.

1.8 RECORD DRAWINGS

A. Record Drawings: Provide a minimum of two complete sets of HVAC, Plumbing, and Fire Protection drawings as Record Drawings and Specifications, which shall be separate, clean, reproducibles for the purpose of showing a complete picture of the work as actually designed, including relevant change orders and RFIs. Submit in hard copy format as well as 2 sets of CD-ROMs. See Division 1 for additional requirements.

B. As-Built Drawings:
1. Prepare two sets of reproducible prints, based on the Contract Record Drawings, showing "as-installed" conditions thereon. It is anticipated that these drawings will be based on the shop drawings.

2. Certify to completeness and accuracy of the “as installed” information indicated on the reproducible prints with signature.

3. As-built drawings shall be submitted in both hard copy and CAD file format.

C. Within 30 days of the date of Final Inspection, deliver the Record Drawings and Specifications, and As-Built Drawings to the Owner.

1.9 OPERATING MANUALS

A. After completion of balancing and testing and commissioning operations, instruct the Owner’s maintenance personnel in the operation, adjustment and maintenance of the mechanical plant for a minimum of 8 man-hours, unless the Owner agrees to a shorter period.

B. Submit three (3) copies of certificates signed by Owner’s Representative, attesting to their having been instructed.

C. Thirty (30) days before Owner’s personnel assume operation of systems, submit six (6) sets of operating maintenance instructions, indexed manuals, and parts lists for all major equipment and that requires or for which the manufacturer recommends maintenance in a specified manner.

D. Provide service manuals to the Owner 30 days prior to final acceptance. Manuals shall include the following information:

1. Part numbers of all replaceable items.
2. Manufacturer’s cuts and rating data.
3. Oiling, lubrication and greasing data.
4. Belt sizes, type and lengths, pulley sizes.
5. Test and balance reports.
6. Serial numbers of all principal pieces of equipment.
7. Suppliers’ names, addresses and phone numbers.
8. Settings for all controls, both control point and throttling range.

1.10 PRODUCT DELIVERY, STORAGE HANDLING

A. Identify materials and equipment delivered to site to permit check against materials list and shop drawings.
B. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract price.

1.11 EXISTING SYSTEMS AND UTILITIES SHUT-DOWN

A. After the Owner has taken occupancy of the building, give the Owner 2 weeks’ advance notice, in writing, of need to shut off existing utility services or equipment interruptions. No system shutdown shall be permitted without the expressed written approval from the Owner. Divisions 21, 22, and 23 shall plan the shutdowns well in advance. The Owner shall set the exact time for and execute shutdown. The request shall state what systems are to be shut down, what areas will be affected, how long the period will be, and what contingency plan is provided if the work cannot be completed within the specified time. This procedure must be established and followed in order to provide the Owner with the least amount of service interruption and the least amount of disturbance for the users of the affected areas.

1.12 SCHEDULING AND SEQUENCING

A. Cooperate with other trades in putting this installation in place at a time when space required is accessible, and in such a manner that all other work in this space may be installed as intended for the project. Schedule work and cooperate with the others to avoid delays, interferences, and unnecessary work, conforming to the construction schedule, making the installation when and where directed.

1.13 TEMPORARY USE

A. Should it become necessary to use the new portion of the system and the new equipment before the completion of this work, the Owner reserves the right to make use of same at its own risk and expense, but the temporary use of the equipment shall not constitute an acceptance of the plant or any part thereof in any way. The Owner will bear the cost of fuel and electrical current for such temporary use of the equipment.

1.14 COMMISSIONING

A. Mechanical systems are to be commissioned by the Owner’s retained Commissioning Agent and the sub-contractors are responsible for providing support to the commissioning work for the respective installations.

1. The Owner will retain the services of a specialty Commissioning Agent consultant to produce the pre-commissioning checklist and Functional Performance Tests (FPTs) and other commissioning criteria. The Contractor shall provide all necessary work to support the commissioning effort.

2. The Commissioning Agent will supervise the Contractor’s commissioning work.

3. Provide all labor and materials needed to operate systems during the commissioning period.

4. Support of the commissioning process is included as a part of the total package of quality assurance and quality control for this project. Commissioning is to be
integrated into the project as the process that oversees and verifies the functional performance of equipment, systems, and assemblies via observation and testing. Include coordination with and full participation in the commissioning process. The support work related to commissioning shall include but not be limited to field observations, factory and site tests, pre-start checks, start-up checks, functional test procedure review, functional performance testing, commissioning meetings, documentation, test interpretation, and deficiency correction. The details of these requirements are described in the above Sections and other referenced Sections and are herby incorporated by reference into the work of this Divisions 21, 22, and 23.

5. See Section 019100 – General Commissioning Requirements for detailed requirements.

B. It is anticipated that the following systems will be commissioned. As the project develops, coordinate with the Owner the exact extent of systems and equipment to be commissioned:

1. Heating, Ventilating, and Air Conditioning Systems
   a. Air handling systems
   b. Exhaust fans
   c. Fan-coil units
   d. Lab control system
   e. High plume exhaust fan
   f. Air inlets and outlets
   g. Fire/Smoke dampers
   h. Filtration systems
   i. Pumping systems
   j. Building Automation System
   k. Testing and Balancing – The Owner may spot check the balancing work using and independent test and balance agency.
   l. Chilled water system.
   m. Heating hot water system

2. Plumbing Systems
   a. Sanitary sewer
   b. Storm and overflow
   c. Domestic cold water
   d. Domestic hot water
   e. Lab vacuum system
f. DI/RO water system  
g. Emergency eye wash/shower system  
h. Industrial cold water system  
i. Lab waste/vent system  
j. Lab compressed air system

1.15 SYSTEM ACCEPTANCE

A. Final Review: Request a final review prior to system acceptance after:
   1. Completion of the installation of all systems required under the Contract Documents.
   2. Completion of the commissioning process.
   3. Completion of identification program.
   4. Completion of cleaning program.
   5. Satisfactory operation of all systems for a period of two weeks.

B. Acceptance shall be contingent on:
   1. Completion of final review and correction of all deficiencies.
   2. Satisfactory completion of the commissioning process.
   3. Satisfactory completion of a minimum of 10 working days acceptance test which shall demonstrate compliance with all performance and technical requirements of the Contract Documents.
   4. Satisfactory completion of the training program and submission of all manuals and drawings required by the Contract Documents.

1.16 GUARANTEE

A. See Division 1. See subsequent Sections for additional requirements. Defective parts will be replaced at no cost to the Owner.

1.17 LEED REQUIREMENTS FOR CONTRACTOR

A. The following are minimum requirements for implementing LEED credits.

B. All Prerequisite Credits are required.

C. Credit WE 3.1 Water Use Reduction
   1. Provide water-saving fixtures to produce a 30% water usage savings.
D. Credit EA 1 Optimize Energy Performance
   1. Participate in achieving a minimum of 35% optimization of energy performance.

E. Credit EA 4 Enhanced Refrigeration Management
   1. Select equipment that minimizes or eliminates the emissions of compounds that contribute to ozone depletion and global warming.

F. Credit EQ 3.1: Construction Indoor Air Quality Management Plan
   1. Conform to the requirements of Construction IAQ Management Plan, as required by LEED requirements.
   2. Protect stored on-site and installed absorptive materials from moisture damage.
   3. Maintain ductwork internal cleanliness as specified.
   4. If air handlers must be used during construction, provide filtration media at return and exhaust air inlets as specified.
   5. Replace filtration media immediately prior to occupancy.
   6. This filtration media replacement is the same as required by EQ 3.2 100% outside air flush-out.

G. Credit EQ 3.2: Construction Indoor Air Quality Management Plan
   1. After construction ends and prior to occupancy, perform building 100% outside air flush-out or testing with specified filtration media.
   2. After flush-out, replace filtration media with new.

H. Credit EQ 4.1: Low-Emitting Materials
   1. Meet or exceed VOC limits for adhesives and sealants. Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168 by, and all sealants used as a filler must meet or exceed Bay Area Air Quality Management District Reg. 8, Rule 51.

I. Credit EQ 6.2 Controllability of System – Thermal Comfort
   1. Provide required individual and multi-occupant space comfort controls, as indicated on drawings.

J. Credits EQ 7.1: Thermal Comfort – Design
   1. Provide a permanent temperature control system to provide operator control over thermal comfort.

1.18 LEED SUBMITTALS

A. The following are minimum requirements for implementing LEED credits.
B. Submit required documentation for each Prerequisite Credit.

C. Credit WE 3.1 Water Use Reduction
   1. Submit product data for each fixture indicating water usage rates.
   2. The AE will submit narrative describing water-saving strategies employed by the project and calculations, using USGBC spreadsheet, showing baseline water usage and project water-saving usage to USGBC.

D. Credit EA 1 Optimize Energy Performance
   1. Submit product data indicating energy usages by equipment or systems.
   2. The AE will submit narrative describing energy-saving strategies employed by the project.

E. Credit EA 4 Enhanced Refrigeration Management
   1. Submit product data indicating types and amounts of refrigerants used.
   2. The AE will submit calculations that demonstrate compliance.

F. Credit EQ 3.1: Construction Indoor Air Quality Management Plan
   1. Submit documentation that an Indoor Air Quality Management Plan was developed, what it was, and that it was implemented, including:
   2. SMACNA IAQ Guidelines Chapter 3
   3. Protection of absorptive materials
   4. Maintaining ductwork internal cleanliness
   5. Filtration return and exhaust air inlets if air handlers are used during construction.
   6. Filtration replaced immediately prior to occupancy.

G. Credit EQ 3.2: Construction Indoor Air Quality Management Plan
   1. Submit documentation indicating compliance with the selected flush-out or test procedures.
   2. Submit documentation for the filtration media used during the flush-out period, including filtration media manufacturer’s name, model number, and MERV value.
   3. Submit documentation that all filtration was replaced immediately, prior to occupancy including filtration media manufacturer’s name, model number, and MERV value.

H. Credit EQ 4.1: Low Emitting Materials
1. Provide a cut sheet and a Material Safety Data Sheet for each adhesive used in the building highlighting compliance with South Coast Air Quality Management District Rule #1168.

2. Provide a cut sheet and a Material Safety data Sheet for each sealant used in the building highlighting compliance with Bay Area Air Quality Management District Reg. 8, Rule 51.

I. Credit EQ 6.2 Controllability of System – Thermal Comfort
   1. Provide submittal data of the Environmental Control System describing the comfort control systems used.
   2. The AE will provide narrative describing the project’s comfort control strategy and provide listings of individual and multi-occupant stations and descriptions of controls for each.

J. Credits EQ 7.1: Thermal Comfort – Design
   1. Provide product data, wiring diagrams, and sequences of operation for the Environmental Control System where it has automatic and/or manual operator control over thermal and humidity comfort.

1.19 SUBSTITUTION OR PRODUCT NOT LISTED AS DESIGN BASIS
   A. Any products submitted as substitution or not listed as the design basis shall meet all mechanical performance, electrical demand, weight, overall dimensions, and acoustical performance. Products named in specifications do not relieve the Contractor’s responsibility to meet the project requirement as specified in the Contract Document.

PART 2 - PRODUCTS

2.1 PIPE IDENTIFICATION MARKERS
   A. Seton, Gemco, Kolby, or equal.
   B. Pipe markers shall be made from outdoor grade acrylic plastic and shall attach to pipe by fully wrapping around it. Marker shall indicate fluid or gas in written form and show direction of flow.
   C. Wording, lettering size and color, marker background color, and color band color-coding shall be in accordance with this section.
   D. Underground Utilities: 6-inch wide minimum, 5 mil thick plastic with metallic backing at 10 feet on centers, 1 mil metallic foil core, green. Tape shall be suitable for buried applications. Provide warning as follows: “WARNING – UTILITY WATER BELOW”, or as applicable.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Arrange to meet with the Owner's Representative at the job site before the work is started and discuss with them the various phases of the work and the procedure and preparation for testing and adjusting the systems.

B. The general arrangement and location of piping, ductwork, apparatus, etc., is shown on the Drawings or herein specified. Minor changes may be necessary to accommodate other work, new or existing, that may conflict with this work. Install this work in harmony with these trades and fully coordinate all work.

C. Visit the site of the work, take measurements, examine all areas where work is to be performed and get such other information necessary for proper execution of the work. Ascertain and check all conditions with the Drawings and Specifications, other trades, existing conditions and by what means the work is to be performed. No allowance shall subsequently be made for any extra expense due to failure or neglect to make such examination and correlation. Where revisions or changes in the existing work are required to permit the installation of new work, they shall be made at no additional cost to the Owner. No allowance shall be subsequently made for any error or omission on the part of the bidder in this connection.

3.2 ACCURACY OF DATA

A. The Drawings indicate the general arrangement and location of piping, ducts, and equipment. Should it be necessary to deviate from arrangement or location indicated in order to meet architectural conditions or site conditions, or due to interference with other work, make such deviations as offsets, rises and drops in piping and ducts that may be necessary, whether shown or not, without extra expense to the Owner. Extreme accuracy of the data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for the assistance and guidance of this Section and exact locations, distances, and elevations shall be governed by actual site conditions.

3.3 COORDINATION ITEMS

A. Coordinate mechanical work with that of other trades in order to:

1. Avoid interferences between general construction, mechanical, electrical, structural and other specialty trades.

2. Maintain clearances and advise other trades of clearance requirements for operation, repair, removal and testing of mechanical equipment.

3. Indicate aisleways and accessways required on coordinated shop drawings for roof equipment area, mechanical equipment rooms, data and telecomm rooms, corridors, ceiling spaces, shafts, corridors, ceiling space, shafts, laboratories, etc.

B. Understanding of Work
1. The Contractor shall have studied, examined, and compared all of the contract documents, including all drawings and specifications. The contractor shall have a full understanding of how the work in this part is scheduled, phased, and installed with work of all other trades.

2. The Contractor shall include in this installation all piping, ductwork, devices, and equipment that are necessary for complete and operating systems as specified and as required.

3. Piping and ductwork from fixtures, outlets, and devices shall be connected full size to the nearest suitable main or riser.

4. Certain installations may be presented as typical, and full details are not repeated for each case. Contractor shall provide complete installation as if full details apply to each and every case, and make adjustments to typical details to suit each specific installation as part of the basic work.

5. Installation of work presented on the diagrams are applicable to the plans, and work depicted on the plans are applicable to the diagrams.

6. If there is a discrepancy in the drawings or specifications, the contractor shall figure the work based on the most stringent requirements to complete the installation and obtain clarification from the Owner Representative before installation.

C. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible. All work shall be above ceilings or ceiling line.

7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Coordinate with individual system requirements.

9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as is practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

12. Coordinate with the locations of electrical panels and avoid installing piping and ductwork over them. Electrical panels are purposely located and have priority for location. The contractor is responsible for all required piping and ductwork offsets to insure that the panels are located as designed and for any other conditions.

13. Perform system modifications recommended by the Test and Balance Agency after recommendations are accepted by the Owner Representative.

3.4 MANUFACTURER'S DIRECTIONS

A. Obtain and follow manufacturer's directions in all cases. Where manufacturer's directions are in conflict with the Drawings and Specifications, submit to Owner Representative for clarification before installing the work.

3.5 INSTALLATION

A. Manufacturer's Directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over drawings and Specifications. Where these are in conflict with the drawings and Specifications, notify the Owner's Representative for clarification before installing the work.

B. Carpentry, Cutting, Patching, and Core Drilling:

1. Provide carpentry, cutting, patching, and core drilling required for installation of material and equipment specified in this division.

2. No penetrations shall be sleeved, cut, or core drilled through concrete construction without a submittal indicating exact locations and sizes and specific written approval from the Owner’s Representative or unless specifically shown on the Structural Drawings.
3. It is the Contractor’s responsibility to accurately size and locate all openings through the structure. The dimensions shown on the Structural Drawings are for general information only. Provide all specific sizes, dimensions, requirements, etc.

C. Seismic Anchorages:
1. All material and equipment, including overhead and floor-mounted equipment, ducts, piping, and appurtenances shall comply with requirements of Section 230529 - Hangers, Supports, and Seismic restraints for HVAC Equipment and Section 230548 – Vibration Controls for HVAC Piping and Equipment.

D. Waterproof Construction:
2. Provide waterproof NEMA 3R enclosures for all equipment or devices mounted outside or otherwise exposed to the weather.


F. Painting of Mechanical Equipment and Hardware:
1. Comply with Division 9 – Finishes.
2. Factory assembled products (not shop fabricated) shall be factory finish painted.
3. Provide moisture resistant paint for all exterior painting.
4. Colors shall be as shown on the drawings unless specified.
5. Comply with individual Sections for other equipment to be painted.
6. Repair damaged galvanizing, paint, or coatings. Use Z.R.C. (no known equal) cold galvanized compound for galvanized repairs.

G. Concrete Equipment Bases:
1. All equipment located on concrete floor inside the building or on grade outside the building, shall be mounted on a concrete base. The concrete base shall be four inches high and shall extend six inches beyond the edge of equipment base unless indicated otherwise on drawings.
2. Coordinate concrete bases: Concrete bases indicated on Architectural or Structural drawings are specified in other Divisions. Concrete bases not on Architectural or Structural drawings are requirements of this Division.
3.6 QUALITY CONTROL

A. Measurements: All materials installed shall be to exact field measurements as determined by Divisions 21, 22, and 23.

B. The installation depicted on the Drawings is designed to fit tightly into work under other Sections or Divisions. It is the essence of this Contract that all work be completely coordinated with all other Sections or Divisions, and that all locations of pipes and ducts be exactly determined in the field and cleared with all other Sections or Divisions before the installation of these items is begun. No extra compensation will be made for failure to observe this clause.

C. Adequate clearance for access to all operable devices and all automatic devices and for access to all lubrication points shall be maintained in all portions of the work.

D. Provide access panels where shown and where required for access to all equipment and operable devices.

E. Gauges, thermometers, and other indicating devices shall be installed so that they may be easily read from the floor.

F. Finish work shall present a neat and workmanlike appearance.

G. Protection of Equipment

1. Take responsibility for damage to any of the work or premises before acceptance. Should any new or existing equipment become damaged, restore it to its original condition and finish before final acceptance. Damage incurred to the Owner’s properties, neighboring properties, or to the work of other Divisions, caused by Divisions 21, 22, and 23, shall be replaced or repaired by, and at the expense of, Divisions 21, 22, or 23 to the satisfaction of the Owner’s Representative. All exposed materials shall be clean at the time of acceptance of the project.

2. During the prosecution of this contract, the existing adjacent buildings will be occupied and in use. Work done under this Contract must be performed without inconvenience to the Owner’s and/or occupants insofar as possible. All building furnishings and equipment of whatever nature, shall be protected at all times and the spaces shall be left clean. Provide temporary dust tight protection wherever required. Provide protection against damage to roof and remove protective material at completion of work.

3. Exercise care during construction to avoid damage or disfigurement of any kind. Protect equipment from dust and moisture prior to and during construction. The Contractor is cautioned that concrete finishing, painting, etc. in electrical rooms shall not proceed if unprotected equipment is installed.

4. Where required or directed, construct temporary protection for equipment and installations for protection from dust and debris caused by construction.
5. All protection shall be substantially constructed with the use of clean canvas, heavy plastic, visqueen and plywood, as required, and made tight and dust proof as directed.

6. Repair by spray or brush painting, after properly preparing the surface, all scratches or defects in the finish of the equipment. Only identical paint furnished by the equipment manufacturer shall be used for such purposes.

7. Failure to protect the equipment as outlined herein shall be grounds for rejection of the equipment and its installation.

H. Quietness of Operation: Quiet operation without excess vibration of all mechanical equipment is a requirement of this installation. Provide, adjust, repair or replace any equipment producing in the Owner's opinion, objectionable noise or vibration in any of the occupied areas of the building, including providing additional brackets, bracing, etc., to prevent objectionable noise or vibration.

1. See Section 230548, “Vibration Controls for HVAC Piping and Equipment” for additional information.

3.7 PENETRATIONS THROUGH CONCRETE CONSTRUCTION

A. No penetrations shall be sleeved, cut, or core drilled through concrete construction without a submittal indicating exact locations and sizes and specific written approval from the Owner's Representative or unless specifically shown on the Structural Drawings.

1. It is the Contractor's responsibility to route all utilities (ducts, pipes, conduits, etc.) through given openings in the shear walls or around the shear walls. Include all labor and materials to accomplish this.

2. It is the Contractor's responsibility to accurately size and locate all openings through the structure. The dimensions shown on the Structural Drawings are for general information only. Provide all specific sizes, dimensions, requirements, etc.

3.8 ACCESS DOORS AND PANELS

A. This Section is responsible for the number of doors required and their accurate placement for access to work of Divisions 21, 22, and 23.

1. This Section is responsible for arranging equipment so that it is fully accessible and serviceable through ceiling tiles, access doors, panels, etc.

2. The Section is responsible for any additional access panels beyond what is shown on the contract documents for complete access to all equipment including equipment which is relocated as a result of the coordination process or equipment that is provided as a result of design-build or performance requirements.

3. This Section shall obtain approval from the Owner's Representative for any added or relocated access doors, panels, etc.
3.9 STENCILING AND IDENTIFICATION

A. Each piece of equipment shall have a factory tag with serial number, model number, performance data, etc.

B. Label each piece of equipment including pumps, fans, tanks, etc., with designations as directed by the Owner. Do not proceed with labeling without approval from the Owner Representative. Labels shall be engraved plastic, with royal blue background and 1/2" high white lettering. State equipment number and scheduled performance data. Attach to equipment with stainless steel screws.

1. Stencil each duct leaving the mechanical area indicating fan unit, area(s), or room(s) served, and direction of air flow

2. Stencil each duct branch leaving an air shaft at each floor with fan number, and identify it as a supply, exhaust, or return duct, and indicate direction of air flow.

C. Post a framed and typewritten schedule of all abbreviations, pipe markers, valve tags, and lubricants used, with identification, shall be framed and posted in each Mechanical Equipment Room, where directed by the Owner.

D. Identify all pipes with specified markers.

1. Install markers on mains, at all branch take-offs, at wall floor penetrations, and adjacent to valves and cocks. Identify service in written form and with color coded direction arrows.
   a. Above grade: every 15 feet.
   b. Below grade: every 8 feet.

2. Apply to underground pipe, all exposed pipes, pipes behind removable tile ceiling, pipes in concealed but accessible locations, such as behind access panels, and at least once in each room.
   a. Install continuous plastic underground warning tapes during backfilling of trenches for the underground piping. Locate 18 to 24 inches directly above the pipe insulation.

3. Install pipe markers in accordance with the manufacturer's directions. The markers shall completely cover the circumference of the pipe and overlap itself. Attach circumferential color coded direction arrows overlapping one end of the marker.

E. See Section 233000, “HVAC Air Distribution,” for warning labeling for hazardous atmosphere at fume exhaust plenums.

F. Valve Tags: Provide numbered, laminated plastic tags for valves installed under this Contract, sized 2" x 4" with royal blue background and 1/2" high white lettering. Each valve shall be tagged to indicate the valve number and its service. Fasten tags to valve with brass chain.
1. Valve numbers required for all main valves, branch valves, zone valves, shut-off, reheat valves, and balancing valves. Include valve numbers, size, service, N.O. or N.C., and flow coefficient and/or GPM if applicable.

2. On the as-built drawings, indicate the location and number of each tagged valve.

3. Provide a computer file database in a form agreeable to the Owner, describing the valve, number, location, type of service, and specific duty of each tagged valve.

G. Place warning signs on all machines driven by electric motors which are controlled by fully automatic starters. See Section 3320, Article 7, Subchapter 3, “General Industry Safety Orders”, Title 8, California Code of Regulations.

H. Smoke Dampers: At each smoke damper access panel, label "Fire/Smoke Damper" in minimum one inch high letters.

3.10 CLEANING AND INSPECTION

A. Thoroughly clean and test all equipment and material before insulation is applied, systems tested, or put into operation.

B. Cleaning shall be as specified under the specific Sections in Divisions 21, 22, and 23.

C. The intent of this Specification is that all equipment and material furnished by Divisions 21, 22, and 23 shall be completely dust-free, clean and rust-free, and freshly painted when the final inspection is made.

3.11 LUBRICATION

A. All lubrication points shall be accessible. Where this is impossible, provision shall be made for lubrication at an accessible location. Where oil is used, an oil level indicator and capped, vented filling connection shall be provided and firmly mounted in an accessible space and shall be connected to the bearing with pipe(s) as required. Where grease is used for lubricant, the pipe shall have a suitable lubricating fitting installed at the accessible end. All equipment shall be thoroughly lubricated before operation and at time work is accepted. All automatic dampers and control linkages shall be properly lubricated. Provide a typed list of all lubricants required for all installed equipment, local dealer, and lubrication schedule. Frame and mount lubrication schedule in mechanical equipment rooms or where directed.

3.12 INSTALLATION OF SEALANTS

A. See Division 7 and Section 26 05 02 - Basic Materials and Methods.

B. Where fire stopping is not required, seal all duct and pipe penetrations through walls and floors for noise/vermin control.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. All carpentry, masonry and steel fabrication involved in making stands and supports for equipment installed under this Divisions 21, 22, and 23, unless specified otherwise.

B. Furnishing and setting of sleeves, rods, inserts, and support and bracing devices for all piping, ductwork and equipment installed under this Divisions 21, 22, and 23.

C. Sizes and locations of all housekeeping pads, piers, and curbs for work of this Divisions 21, 22, and 23, unless shown or specified otherwise. See architectural and structural drawings for details.

D. Concrete inertia bases where shown or specified for equipment under this Divisions 21, 22, and 23.

E. Complete closing and sealing of all openings around pipes and ducts furnished under Divisions 21, 22, and 23. Maintain all fire separations.

1.2 RELATED DOCUMENTS

A. Section 019113 – General Commissioning Requirements

B. Section 230500 – Common Work Results for Mechanical.

C. Section 230548 – Vibration Controls for HVAC Piping and Equipment.

D. Section 232113 – Hydronic Piping and Valves.

E. Section 232202 – Heating Hot Water Boilers

F. Section 232430 – Air-Cooled Electric Chiller

G. Section 233000 – HVAC Air Distribution.

H. Section 233400 – HVAC Fans.

I. Section 237300 – Air Handling Units.

J. Section 237305 – Split Air Conditioning VRV System

1.3 SUBMITTALS

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for Mechanical.

  1. Connections to structure.
a. Weight, calculations of loads, anchor sizes and imbed depths.

2. Steel for supports.

3. Fabricated steel and concrete bases.

4. Pre-engineered seismic bracing systems.

5. Shop Drawings
   a. Dimensioned plans showing dimensioned sizes and locations of curbs, pads, and inserts.
   b. All fabricated equipment supports and inertia bases.
   c. Support and bracing details, including bracing, for pipes, ducts, and suspended equipment.
   d. Access platforms, ladders and safety cages, etc.
   e. Hoist eye bolts at pumps.

6. Structural calculation prepared and stamped by a California registered structural engineer.

1.4 OPERATIONS AND MAINTENANCE

A. Submit under provisions of Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. Support devices.
   2. Anchor devices.
   3. Seismic bracing devices, systems, and calculations

1.5 REGULATIONS

   2. Expansion Anchors: California Building Code

1.6 SCOPE

A. Contractor is responsible for design/build of all the Div. 21, 22, and 23 utility support and seismic restraints as specified by this section.

PART 2 - PRODUCTS

2.1 ATTACHMENTS TO STRUCTURE

A. Connection to Existing Concrete Structure: Hilti TZ bolts, Redhead, or equal, wedge type expansion anchors.
B. For Suspension from New Formed Concrete Structure: B-Line B3014, Grinnell Figure 282, Superstrut 452, or equal, adjustable concrete insert.

C. For suspension from New Concrete on Metal Deck: B-Line B3019, Superstrut C-475, or equal.

D. For concrete deck hanger strap insert: B-Line Fig 109 or equal.

E. For Support on New Concrete: Galvanized steel hook bolts.

F. Welded Connection to Steel Beams: B-Line B3083, Grinnell, Superstrut, or equal, steel welded beam attachment.

G. Clamp Connection to Steel Beams: B-Line, Grinnell, Superstrut, or equal, beam clamp with retaining clip style as required by load.

H. See drawings for further details.

2.2 SUPPORTS, BRACING, AND ACCESSORIES

A. Miscellaneous Steel: Angles, channels, brackets, rods, clamps, etc., of new materials conforming to ASTM A36.

1. Hot-dip galvanize all steel parts after fabrication or factory applied where used above the outdoors or inside air plenums.

B. Fasteners: All bolts and nuts, except as otherwise specified, shall conform to ASTM Standard Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts shall have heavy hexagon heads, and nuts shall be of the hexagon heavy series. Provide bolts of ample size and strength for the purpose intended.

1. All bolts, washers, nuts, anchor bolts, screws and other hardware used outdoors or inside air plenums, shall be hot-dip galvanized, and all galvanized nuts shall have a free running fit.

C. Sheet Metal Screws: Plated, size 10 minimum.

D. Hanger Rods: B-Line, Grinnell, Superstrut, or equal, plated steel rods, threaded, with a minimum safety factor of 5 over the imposed load.

1. Factory or shop hot-dip galvanized outdoors or inside air plenums and electro-galvanized indoors.

E. Pipe Hangers: See Section 232113 – Hydronic Piping and Valves. Provide rod sizes to meet Section 232113 requirements.

F. Pipe Thermal Expansion Control: B-line, Grinnell, or equal, guides, rollers, skids, saddles, etc. Pipe anchors field constructed.
G. Duct Hanger Straps: See Section 233000 – HVAC Air Distribution.

2.3 SEISMIC RESTRAINT

A. Materials: Steel and fasteners as specified herein.

B. Piping, Duct, and Equipment Restraint:

1. Design nonstructural component and equipment anchorage to the main structure including component parts, connections and related hardware, per California Building Code Section 1632a, so that the completed installation meets or exceeds the following requirements:

   a. Importance Factor for Seismic Loading (I_P):
      1) I_P = 1.5 for Life Safety Systems
      2) Exhaust fans and ducts serving fume hoods.
      3) Supply fans / air handlers and ducts serving makeup air for fume hoods.
      4) Fire sprinkler piping. See Section 211000 – Water-Based Fire Suppression Systems
      5) See Division 26 for list of electrical-related equipment.
      6) I_P = 1.0 for all other systems

   b. Seismic Zone: 4

   c. C_a Value for use in CBC Section 1632: 0.36, or as directed by the structural engineer.

   d. Horizontal Force Factor values, a_p and C_p, are from CBC Table 16-O, or as directed by the structural engineer.

   e. Building heights are as shown in the Drawings.

   f. Service Seismic Drift, Δ_s, 0.005 times building height, or as directed by the structural engineer.

   g. Maximum Seismic Drift, Δ_m, 0.015 times building height, or as directed by the structural engineer.

2. Utilize custom engineering and/or pre-engineered seismic restraint systems approved by OSHPD. In the first case, provide structural calculations stamped by a Professional Structural Engineer licensed in the State of California including, but not limited to the following:

   a. A repetition of the design criteria contained in the specifications. Conform to requirements of the CBC, unless otherwise noted in the specifications.

   b. Calculations to determine dead, live, and earthquake loads of components and component supports.

   c. Analysis of component anchorage and supports to the main structure.
d. Cross reference structural calculations to the applicable production and erection shop drawing details.

e. Show the loads applied to the main building structure in shop drawings or in drawings in the calculations with clear references to locations in the main building structure.

PART 3 - EXECUTION

3.1 ATTACHMENTS TO STRUCTURE

A. Concrete Structure:
   1. Locate anchors at least six (6) bolt diameters from any edge condition and at least ten (10) bolt diameters from any other anchor. Provide a minimum of six (6) bolt diameters embedment into concrete, unless otherwise noted on the Drawings.

   2. Limit load at concrete-filled steel deck to no more than 750 pounds per flute per beam bay (approximately 7 feet), except as noted in drawings. Weights exceeding this restriction to be supported from the steel structural elements using engineered spreaders attached to the structural steel.

3. See Structural Drawings for additional restrictions for locating anchors.

4. Conform to CBC for drilled-in expansion bolts.

B. Steel Structure: Attach at beam axis. Avoid eccentric loads wherever possible.
   1. Where slack cable bracing is used, the cable size, spacing, and connection are to be as recommended by the slack cable bracing system manufacturer.

   2. See contract document for further details.

C. Rating: Ultimate strength at least five times the imposed load.

D. Submit for Structural review all pipe hanger locations, point loads and structural attachment details for pipes 6” and larger.

E. Coordinate installation so that attachments to structure are made prior to fireproofing. If attachments must be made after fireproofing, then thoroughly clean area of fire proofing before welded or bolted attachments are made and replace fireproofing as necessary.

F. Where point loads, imposed by work of Divisions 21, 22, and 23, are greater than can safely be carried by the deck, provide structural steel spreader beams tied to the building structure. Submit details of all such spreader beams for approval.

3.2 SUPPORTS, BRACING, AND ACCESSORIES

A. This Section is responsible for the proper selection and sizing of all support, bracing, and guiding elements of any single or trapeze systems that include duct, pipe, and/or
electrical conduit or cable trays, including those in the laboratories. The Contractor shall retain the services of a specialty support system provided to evaluate all loads due to weight, seismic forces, thermal expansion, etc., and perform all calculations and prepare detailed shop drawings for complete support, bracing, guiding, and anchoring systems based on the layouts shown on the Drawings. See Drawings for typical laboratory arrangements.

1. All support, bracing, guiding, and anchoring systems used outdoors or inside air plenums to be hot-dip galvanized or stainless steel.

B. Set all machines and devices dead level, except where pitch or slope is specified or shown, and securely fasten to the structure unless shown otherwise. Use dry pack cement grout to obtain complete contact between structure and equipment. Provide steel bracing as shown and specified to resist earthquake loads.

C. Concrete Work: Pads, curbs, and piers for equipment furnished under Divisions 21, 22, and 23 shall be located and sized under Divisions 21, 22, and 23 and installed under Division 3. Inform Division 3 that all concrete shall be finished and surface hardened. This Section is responsible that forms, anchors, embeds, embedded channels and bases are properly set in the correct location. Carefully lay out all anchor locations before concrete is poured.

1. Provide housekeeping pads for all equipment provided unless specifically indicated otherwise. Nominal size is 4 inches high unless indicated otherwise.

D. Pipe Support and Bracing:


4. Brace all piping trapezes.

5. Install sleeves wherever pipes are run through walls, and floors to allow large enough openings for the passage of the pipe and pipe insulation when required. Sleeves shall be of sufficient size to allow for contraction and expansion of pipe. The space between each pipe and sleeve (or insulation and sleeves) shall be completely closed by packing with code approved mineral fiber materials with a suitable binder or other approved packing material. Sleeves at floors are to extend 2" minimum above structural slab or finished floor whichever applies. Seal all penetrations through all fire rated construction (walls, ceilings, floors) with approved materials providing equivalent protection and rating of the construction being penetrated. See Section 232113 – Hydronic Piping and Valves.

6. Support all pipe from the building structure so that there is no apparent deflection in pipe runs. Fit piping with steel sway braces and anchors to prevent vibration and/or horizontal displacement under load when required. Do not support from, or brace to, ducts, other pipes, conduit, or any materials except building
structure. Piping or equipment shall be immobile and shall not be supported or hung by wire, rope, plumber's tape, plastic ties, or blocking of any kind. Vertical piping running between floors shall be additionally supported at mid-points in a rigid and immobile fashion. Any exposed or concealed piping which can be physically moved, and which is not properly supported will not be accepted, and additional support or bracing will be required. Install seismic bracing as hereinbefore specified; see Seismic Restraint.

7. Install and secure all equipment with anchors and braces to floors, structural members and walls with sufficient backing, to prevent vibration and/or horizontal displacement under load and seismic force as hereinbefore specified. Follow manufacturer's recommendations for the installation of vibration isolators where required for all equipment requiring such.

8. Provide field built pipe anchors for building expansion joint and thermal expansion control designed to withstand the greater of the expected forces or 500 pounds of thrust per pipe diameter inch. Provide all guides, rollers, skids, saddles, expansion loops, expansion joints, etc. for a complete system.

E. Duct Support and Bracing:

1. Support duct risers from structure at each floor penetration.

2. Ducts Supported From Above: Attach to structure using specified attachments. Minimum rod or bolt size is 3/8”.


4. Double fold strap at attachment to structure or use single fold and washer, where drilled-in anchors are necessary.

5. Provide special supports where shown on the Drawings.

   a. Brace duct risers rising from fan discharges, starting at the fan discharges.


8. Duct straps shall be used in concealed installation only. Use threaded rods and strut systems for exposed installation. Duct straps can be used for the interstitial floor.

9. **Cable type supports are not acceptable.**

F. Platforms and Ladders

1. Provide or coordinate with the provider, all platforms and ladders including all safety railing, cages, toe-kicks, etc. Railings shall be removable where required.
for access. Construction shall be in accordance with applicable safety regulations.

END OF SECTION 230529
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Thermal and acoustic insulation for pipes, ducts, plenums, equipment and supports provided under Divisions 22 and 23, except insulation specified in other Sections.

1.2 RELATED DOCUMENTS

A. Section 230500 – Common Work Results for Mechanical
B. Section 232113 – Hydronic Piping and Valves.
C. Section 221000 – Plumbing, Piping and Valves
D. Section 232114 – Hydronic Systems for HVAC
E. Section 233000 – HVAC Air Distribution: Internal acoustic insulation for ducts, acoustic plenums, and fire rated duct wrap.
F. Section 232123 – Hydronic Pumps

G. Section 237305 – VRV System

1.3 SUBMITTALS

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. Duct insulation.
   2. Piping, valve and fitting insulation.
   3. Equipment insulation, including pumps.
   5. Removable covers, access panels, etc.
   6. Cements and finishes.
   7. Application procedures.

1.4 OPERATIONS AND MAINTENANCE DATA

A. Submit under provisions of Division 1 and Section 23 05 00 – Common Work results for HVAC.
   1. Duct insulation.
   2. Piping insulation.
3. Equipment insulation.

1.5 CODES, REGULATIONS AND STANDARDS

A. Underwriters' Laboratories Test Method No. 723: Fire Hazard Classification.

B. Mechanical, Plumbing, Fire, and Energy Codes of latest issues.

C. Factory Mutual Standards.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Manufacturers: Owens-Corning Fiberglas Corp., Knauf, Schuller, Certain-Teed, or equal.

B. Fire Hazard: Provide insulation, jackets, facings adhesives and accessories acceptable to the State Fire Marshal, and meeting the requirements of NFPA 90A. Meet the following hazard classifications stated in accordance with U.L. Test Method of Fire Hazard Classifications of Building Materials, No. 723:

1. Flame spread: Maximum 25.
2. Fuel Contributed: Maximum 50.
4. Test results shall be available from an approved testing laboratory to indicate that hazard ratings for materials do not exceed the above amounts.

2.2 DUCT INSULATION

A. Concealed Supply and Return Air Ducts and Return Air Boot within Building: Insulate on the outside with minimum 1-1/2" thick blanket material of fine inorganic glass fibers with foil face.

1. Density: Not less than 1.0 lb. per cu. ft.
2. Minimum R value: 4.5 Hr. deg F ft²/BTU, at 68 deg F. mean temperature.
3. If internal insulation is shown on the Drawings then external insulation is omitted.

B. Exhaust ducts: Provide internal insulation to general exhaust ductwork as specified in Section 23 30 00 only as noted in the drawings to achieve indoor acoustic requirements. No insulation is required for fume hood exhaust ducts. No insulation is required for general building exhaust ducts if internal lining is not indicated in the drawings.

C. Exposed outdoor supply ducts: See Section 3.02.A.2.
2.3 PIPING INSULATION

A. Fiberglass

1. Material: Two-piece, 4.2 pounds per cubic foot density fiberglass pipe insulation with an embossed vapor barrier laminate jacket. The jacket shall have a pressure sealing lap adhesive. Owens Corning Fiberglass ASJ/SSL-II, or equal.

B. Closed Cell flexible elastomeric thermal insulation for suction and liquid line of refrigerant piping and condensate drain lines from ceiling hung fan coil units or evaporator units of split systems:

1. Armstrong Armaflex Ap 1” closed cell insulation, or approved equal with aluminum jackets as specified hereinafter for exposed indoor and outdoor installation.

C. Calcium Silicate

1. Material: 13.8 pounds per cubic foot with thermal conductivity of 0.36 BTU/hr-ft2-degrees F/inch at 200 degrees F with aluminum jackets as specified hereinafter.

D. Thickness, in inches:

<table>
<thead>
<tr>
<th>Service</th>
<th>Medium Temperature Range, deg F</th>
<th>Pipe Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water and Fire Piping Outdoors</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Storm Drain, Rainwater Leader Horizontals Only</td>
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<td>0.5</td>
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<tr>
<td>Cooling Coil Condensate Drains*</td>
<td>Any</td>
<td>0.5</td>
</tr>
<tr>
<td>Sanitary sewer, where serving cooling coil condensate drains, drain bodies and pipe from drain body to main riser</td>
<td>Any</td>
<td>0.5</td>
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<tr>
<td>ADA Plumbing Insulation</td>
<td>See Section 221000 – Plumbing, Piping and Valves</td>
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<tr>
<td>Heating Hot Water System</td>
<td>60-200</td>
<td>1.05</td>
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<tr>
<td>Chilled Water</td>
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<td>1.0</td>
</tr>
<tr>
<td>Domestic/Industrial Hot Water System</td>
<td>60-200</td>
<td>1</td>
</tr>
</tbody>
</table>

*Insulate condensate drain pipes exposed and concealed in ceiling and wall space.

2.4 EQUIPMENT INSULATION

A. Heating Hot Water Pumps, Air Separators, and other Equipment:
1. Owens Corning Fiberglas 700 Series, Manville 800 Series, or equal, 1-1/2" thick, 6 PCF density, unfaced board insulation, consisting of inorganic glass fibers bonded with a thermosetting resin. Suitable for temperatures up to 450°F.
   a. Insulation at pumps shall be easily removable and replaceable.
   b. Insulate entire pump casing.
   c. Apply vapor barrier to seal all gaps for chilled water pumps and associated equipment.

B. Chilled Water Pumps and Air Separators:
   1. Two-inch thick AP/Armaflex sheet with vapor barrier.

2.5 ATTACHMENT DEVICES, CEMENTS AND FINISHES

A. Insulation Cement: Manville No., 460, or equal, mineral wool based insulating cement with good adhesion to cold surfaces, and rated to 1800 degF.

B. Lagging Adhesive: Arabol E1658E, Foster 30-36, or equal, thinned per manufacturer's instructions.

C. Vapor Barrier Coating: Non-flammable, fire-resistant, polymeric resin, compatible with insulation.

D. Spray Mastic: Insulcoustic 551, Foster 35-01, or equal.


F. Bonding Adhesive: Foster 85-17, or equal.

G. Insulation Jackets:
   1. Supply Ductwork
   2. Where indicated Outdoor Installation: 0.016" inch smooth aluminum with 0.0025" thick smooth aluminum fitting covers and 0.0010" thick aluminum clamps

H. Fitting, Valves, Flanges, Strainers Insulation Jacket:
   1. Indoors: Pre-formed polyvinyl chloride (PVC)
   2. Outdoors: Pre-formed 0.016" aluminum.

I. Clip Pins: DuroDyne, or equal (no known equal), 18 gauge metal stick-pins with self-locking steel washers suitable for welding or glue-on attachment to sheet metal.
2.6 INSULATION FOR INDOOR HEATING HOT WATER, VALVES, CONTROL VALVES, CIRCUIT SETTERS, AND STRAINERS

A. Removable/reusable Insulation Covers: Ohio Valley Industrial services "HOT CAPS", Extol, or equal. To consist of silicone coated glass cloth inner liner, specified fiberglass pipe insulation, silicone coated glass cloth outer jacket material and fastening systems. Fastening systems to include belts with stainless steel O-rings to ensure weather-tight fit. All seams to be double stitched inside out except for the closing seam which is to be double top-stitched.

PART 3 - EXECUTION

3.1 GENERAL

A. Apply all insulation in a neat and workmanlike fashion, in maximum continuous lengths, with all butt and lap joints and seams secured.

3.2 DUCT INSULATION

A. Materials

1. Concealed Supply and Return Ducts within Building: Specified blanket insulation without additional jacketing, unless internal insulation is required.

2. Supply and Return Air Ducts on Roof: Specified foil-faced board insulation with additional aluminum jacketing.

B. Seal external board insulation joints and seams with aluminized tape.

C. Where it is not possible to insulate ducts after installation, insulate duct before final installation. Tightness of work shall not be accepted as a valid reason for omitting any insulation. Where insulation is omitted, ducts shall be removed, insulated and reinstalled.

D. On outdoor duct, pitch horizontal duct insulation with build-up insulation for drain.

3.3 PIPE INSULATION

A. Materials

1. Heating hot water, hot water:
   a. Within mechanical rooms or outdoors, to be insulated with specified calcium silicate insulation and covered with specified aluminum jacket.
   b. At all other locations – specified fiberglass without jackets.

2. Chilled water piping:
   a. Outdoors, inside air handlers, and mechanical room to be insulated with specified insulation and covered with aluminum jacket. The insulation system shall be completely vapor sealed before the jacket is applied.
b. At all other locations – specified fiberglass without jackets.

B. Concealed and Exposed Piping Insulation: Apply over clean and dry surfaces butting adjoining sections firmly together. Seal insulation smoothly and secure with self-sealing longitudinal lap using nylon sealing tool. Adhere factory furnished 3" wide pressure sealing strips to all butt joints and end joints.

C. Fittings, Valves, and flanges for outdoor installation shall have an insulation thickness no less than the adjacent piping but be removable without damage for easy re-application. Insulate all fittings, flanges, valves, and strainers less than 4" size with polyvinyl chloride (PVC) plastic factory pre-formed jackets with factory pre-cut insulation. In all cases where the one-piece factory molded PVC insulated fitting jackets are used, apply two layers of the proper factory supplied, pre-cut fiber glass insulation. Tuck the ends of the fiber glass insulation snugly into the throat of the fitting, and tuck in the edges of the adjacent pipe covering. Hold the fiberglass in place by wrappings of twine. Cover the circumferential edges of the jacket with glass cloth soaked in lagging adhesive, overlapping the joint 2" on either side. Fitting shall not deform permanently under pressure. Any fitting not packed or sealed completely will not be accepted. For valves and strainers 4" and greater install specified removable/reusable insulation covers per manufacturer's directions. Ensure a snug fit around valve or strainer and adjacent piping. Provide weatherproof jacket.

3.4 EQUIPMENT INSULATION

A. Pumps and other equipment and all interconnecting piping between insulated components shall be insulated with 1-1/2" or 2" thick insulation in block or board form as specified above. Cut insulation to fit contour of the equipment. At nameplates, operators, control instruments or other devices, neatly terminate and trim edges with glass cloth, 3" or more in width, glued to equipment and to insulation. Finish with two 1/4" coats of insulating cement and wire reinforcing mesh. Wrap insulating cement with glass cloth soaked in lagging adhesive.

B. Unions, strainer caps and valve bonnets shall have removable sections of insulation. Termination at unions, strainer caps, nameplates etc., shall be neatly trimmed with glass cloth soaked in lagging adhesive. All insulated unions, strainers and valves shall be marked.

C. All equipment requiring access for maintenance, repair, replacement, etc., shall have removable insulation access doors on panels, etc. to allow complete access.

3.5 FINISHES

A. Vapor Barrier: Insulation on chilled water pipes, pumps, pipe supports, pumps, valves and specialties shall be continuously covered with an approved vapor barrier. Apply two coats of the approved vapor barrier coating over all surfaces and lagging not covered with continuous vapor barrier jackets. Fill all joints, cracks, seams and depressions, and apply additional lagging as necessary to form smooth continuous surfaces.
B. Ductwork outdoors: Apply aluminum jacket. Lap joints 2" minimum. Attach with aluminum bands 18” o.c. Apply vapor barrier to all joints and seams. Screws are not allowed.

C. Pipe and fitting insulation at any insulated pipe in mechanical rooms, outdoors, or inside air handlers: Apply aluminum jacket. Lap joints 2" minimum. Attach with aluminum bands 18” o.c. Apply vapor barrier to all joints and seams. Screws are not allowed.

END OF SECTION
PART 1 - GENERAL

1.1 OVERVIEW

A. The intent of this Specification is to define the hardware and control requirements for the airflow and temperature control of laboratories. The system specified shall be based on variable fume hood exhaust volume with sash position reset control of fume hoods, synchronization of supply and exhaust airflows, and control of lab room temperature via reheat coils and airflow reset.

B. All control equipment required to fulfill this Specification shall be manufactured and provided by the laboratory airflow control equipment manufacturer.

C. It shall be understood that the Drawings and Specifications describe the approximate locations of the work. Do not scale the drawings to determine exact positions and clearances. Obtain from Architect, Engineer, Commissioning Agent or the Owner any dimensions not shown.

D. Details of construction and of workmanship where not specifically described herein or indicated on the drawings shall be subject to the Engineer's or Owner's approval. It is the intent of these Specifications to provide complete systems, left in good working order, ready for operation, including necessary labor and materials, whether or not specifically shown on the Drawings or mentioned herein.

E. Before submitting proposals, examine the Specifications and all Drawings relating to the work and become fully informed as to the extent and character of the work and the relation of the work to that of other Sections. Examine the Drawings of other Sections to become familiar with all the problems and details of the building construction and to note conditions, which affect the work.

F. A Technical Proposal shall be submitted to the Engineer's office on or before bid day describing the laboratory airflow control system proposed in detail. It shall include a "line-by-line" comparison to the specifications and a statement of compliance or non-compliance to the specification on a "line-by-line" basis. Where there is non-compliance, details on the product and system as proposed shall be provided with an explanation as to why it should be accepted as an alternate.

G. Any changes required in the ductwork, air handling equipment or any other mechanical systems, which would be required for the application of any proposed Laboratory Airflow equipment other than the specified "Base Bid" or "Basis of Design" shall be the responsibility of the laboratory airflow control system supplier. Any additional engineering, sheet metal or mechanical equipment (i.e. upsized supply/exhaust systems) costs other than that as required by the "Basis of Design" shall be borne by the laboratory airflow control system supplier. All changes shall be subject to prior approval by the Architect/Engineer.
H. Only those systems specifically named under “acceptable manufacturers” or through addendum shall be considered for approval. Other systems submitted after the bid opening will be returned without review.

1.2 DESCRIPTION OF WORK

A. Furnish a laboratory airflow control system including fume hood exhaust valves, general lab exhaust valves, and supply valves, room differential pressure controller, fume hood occupancy sensors, and fume hood face velocity monitor/controller. The system provided shall be complete in all respects, including required control accessories, hardware, and software and peripheral devices necessary to execute the sequence of operations. All installation labor shall be as stated below under “Work By Others”. Lab air flow differential and temperature controls shall be by the Building Automation System as indicated on the Contract Drawings.

B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.

C. The laboratory airflow control systems The fume hood face velocity controller shall digitally interface to the Building Automation System (BAS) as provided by the temperature control contractor. The laboratory airflow control contractor shall be responsible to provide an interface device between the laboratory airflow controls and the BAS.

1.3 WORK BY OTHERS

A. The Building Automation System (BAS) contractor shall be responsible for the following:

1. Installation of all LACS (laboratory air control systems) controllers, with exception to sash sensors and fume hood monitor displays. (Sash sensors and fume hood monitor displays shall be supplied by the LACS and factory mounted by fume hood manufacturer.)

2. Provision, installation and final termination of all control wiring, including network communications wiring to LACS. (Refer to BAS section for control wiring specifications.)

3. Provision and installation of power wiring to all LACS controllers as required.

4. Provision of laboratory reheat control valve (where required). Valve requirement shall receive either a 4-20 mA signal.

B. Division 23 shall:

1. Install all laboratory reheat valves (where required) as provided by BAS contractor.

C. Division 23 shall:
1. Install all laboratory airflow control system air valves provided by the LACS contractor.

2. Provide a minimum of two (2) duct diameters of straight duct upstream from every laboratory airflow control system air valve provided by the LACS contractor to ensure lowest pressure drop for the device.

3. Install all airflow measuring devices in ductwork provided by the LACS contractor.

4. Standard fittings, hangers, and ancillary devices required to install duct devices shall be provided by this contractor.

D. The air balancing contractor shall:

1. Verify fume hood face velocities, airflow volume readings and control points in each control mode. Coordination of such shall be through LACS contractor.

E. Fume hood certification

1. Fume hood shall be certified by qualified fume hood certifier.

1.4 SYSTEM TURNOVER

A. Equipment and the entire system shall be commissioned by the laboratory airflow controls system contractor.

B. The LACS contractor shall demonstrate to the Engineer the ability of the controls to maintain setpoints in all modes of operation.

C. Include final as-builts of the installation.

1.5 TRAINING/OWNER’S INSTRUCTION

A. The laboratory airflow control system contractor shall provide two sessions of (8) hours of training to site personnel in the use and maintenance of the laboratory airflow controls provided. Training shall be conducted during normal working hours and shall consist of both hands-on and classroom training at the job site.

B. The controls contractor shall be responsible to provide training to site personnel in the use and maintenance of all controls and systems related to the lab controls.

1.6 GUARANTEE

A. The laboratory airflow control system contractor shall provide two (2) years standard warranty, including parts and labor.

1.7 QUALITY ASSURANCE

A. Laboratory airflow controls system contractor shall provide written approvals and certifications after installation has been completed.
B. LACS contractor must prove that he has been engaged in the provision, installation and service of this type of equipment for at least five (5) years and has a fully equipped, factory trained and authorized service organization.

C. For any equipment submitted for approval, the LACS contractor shall state what, if any, specific points of the system operation differ from these Specifications.

D. The LACS contractor shall continue to bear the liability for replacement of substituted equipment in the event that the equipment fails to perform as specified, or to meet approval of all authorities having jurisdiction, within twenty-four (24) months after beneficial use by the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are:

1. Critical Room Controls – Closed Loop Venturi, Room Differential Pressure Controller, Fume Hood Face Velocity Controllers, and Occupancy Sensors.

2.2 GENERAL

A. The laboratory airflow control system shall include the following components:

1. Fume Hood Exhaust Air Valves (consists of airflow control valve with airflow sensor and electric actuator).

2. Fume Hood Face Velocity Controllers and Display units (consists of controller, display and sash sensors).

3. General Exhaust Air Valves (consists of airflow control valve with airflow sensor and electric actuator).

4. Supply Air Valves (consists of airflow control valve with airflow sensor and electric actuator).

5. Exhaust Airflow Measuring Device (consists of insertion airflow probe w/ integral transmitter).

6. Fume hood occupancy sensor for face velocity reset.

7. See controls drawing for further details.

8. Room differential pressure controllers.

2.3 FUME HOOD AIRFLOW VOLUME CONTROLLER

A. Exhaust airflow volume shall be controlled based on sash position at each laboratory fume hood by a dedicated fume hood controller. The fume hood face velocity controller shall be a fully functioning, independent control unit, capable of operating as a standalone element in a distributed laboratory airflow control system. Control hardware
distribution shall be such that the failure of one controller shall not affect any other fume hoods on the network. The fume hood controller shall have integrated BACnet MS/TP communication with a touch screen user interface.

B. The fume hood controller shall consist of a controller, display module, sash position sensors, sash position transmitter and interface with the fume hood exhaust valve. The sash position sensors shall mount physically on the fume hood sash and frame assemblies and cable-connect to the transmitter. The transmitter shall cable-connect to the controller.

C. The fume hood controller shall also have integral Airflow Measurement Circuitry to receive a signal directly proportional to duct air velocity, from a vortex-shedding type airflow measuring device, for the purpose of monitoring and controlling fume hood airflow volume. The signal shall be digitally processed by the controller, with no analog-to-digital circuitry required, eliminating A/D conversion error. The airflow measurement shall be incorporated in the control sequence as performed by the airflow controller, and communicated to other airflow controllers, via the network, as required. Measurement system accuracy shall be plus or minus 2% of volumetric airflow rate. Turndown capability shall be at least 10:1.

D. The fume hood sash shall be fitted with sash position measuring sensor(s) and associated sash position transmitter. Vertical position measuring devices shall be of the retracting drawstring potentiometer type. The sensors shall be permanently affixed to the fume hood structure and the drawstring affixed to the moving sash frame as best fits the particular hood design. The sash sensor transmitter shall convert potentiometer resistance values to a linear 4-20 mA output signal. The monitor shall have input ports for up to four (4 sash position measuring arrays for application on multiple-sash hoods. The monitor shall be cable-connected to and powered by the controller.

E. Horizontal position sensors shall be magnetic reed switch type, and utilize true proximity location sensing technology as opposed to resistance measurement. The sensor strip shall mount on the hood structure and a magnet shall be affixed to each sash frame. The horizontal sensing system shall be capable of measuring any number of sashes for hood widths up to 16'.

F. The transmitter/controller module shall be microprocessor based. The transmitter module shall be powered by 24VAC. It shall be provided with two 4-20mA analog outputs, two contact inputs, a SPDT alarm relay output, and an RS-485 communications port.

G. The RS-485 communications port shall provide communications with all other lab airflow and fume hood face velocity controllers in the facility via a single network operating at 625 kilobits speed. This shall be a peer-to-peer, token pass type of communications network. The individual controllers shall not be dependent upon this communications port for operation, and communication interrupts shall not slow the control response of the system. In the event that the network continuity is broken, the controllers shall automatically re-configure so that the labs will continue to control.
H. In the controller, the actual fume hood exhaust duct airflow (CFM) shall be compared to the desired fume hood exhaust airflow setpoint. The setpoint shall be continuously reset proportional sash open area, based on sash position.

I. Control equations shall be of the P+I type. Microprocessor based controllers shall read the airflow, perform control calculations, and update the output to the damper a minimum of ten times per second. Floating "Gap" control will not be acceptable.

J. The controller shall output a 4-20mA electronic signal to the airflow control valve, as specified elsewhere in this document. Control response time shall be sufficient to contain fumes at all times when the sash is opened. The air flow reading from the fume hood exhaust valve is to hardwired to the Building Automation System for air flow tracking and temperature controls.

K. The fume hood controller shall be capable of communicating digitally with the supply and general exhaust airflow controllers and a communications adapter via an RS485 digital peer-to-peer, token-pass network operating at 625 kilobits speed. The adapter shall permit connection to the BAS. All appropriate parameters, including sash position, face velocity, airflow, setpoint, alarm limits, output, and override condition, shall be available for communication to the BAS.

L. The fume hood controller shall be fully configurable via Notebook computer. The tool shall have a keypad and digital display. Configuration shall be accomplished through simple operator-selectable menus.

M. The Controller shall have unoccupied mode capability. A digital input shall be assignable, through menu selection, to effect the transfer from occupied to unoccupied mode. The “Low Face Velocity Alarm” setpoint shall be replaced by a lower, adjustable, “Low-Low Alarm” setpoint during the unoccupied mode.

N. The unoccupied mode shall have the menu-selectable option for a countdown period with audible and visual warnings of the pending transfer to unoccupied mode. The duration of the countdown period shall be adjustable from 10 to 60 minutes in 10 minute intervals. The adjustable parameters shall be adjusted using the hand-held programming tool or a PC.

O. The Fume Hood Face Velocity Controller shall have an emergency or of fire alarm mode to adjust the exhaust air volume down to the specified emergency mode CFM as indicated in the Contract Document. The fume hood Face Velocity Controller shall automatically reset to normal operation if the fire alarm mode is reset by the Fire Alarm System via the BAS interface.

P. Provide an occupancy sensor for each fume hood as specified as VAV operation in the Contract Document.

Q. Hood Sash Position Sensor (VSS Vertical, HSS Horizontal & CSS Combination)
1. The fume hood sash sensor shall continually measure hood sash opening area. The sensor shall support vertical, horizontal and combination sash configurations.

   a. The vertical Sash sensor (VSS) shall consist of a precision measurement reel connected to a return spring assembly. The combined resolution and accuracy shall not exceed 0.1%. The SPS shall be mounted in a concealed location and coordinated with fume hood manufacturer. Control system shall be capable of measuring full opening range of hood sash 0% to 100%.

   b. The Horizontal Sash sensor (HSS) shall consist of flat bars to be affixed to the horizontal sash panels or sash frame based on hood manufacturer. The SPSH shall measure the horizontal sash panel overlap area and calculate the total sash open area.

   c. The Combination sash sensor (CSS) shall consist of both vertical (VSS) and horizontal (HSS) strategies. The control logic shall measure both areas in a dynamic equation for calculating total sash open area.

2.4 FUME HOOD CONTROLLER DISPLAY

   A. The fume hood controller shall provide a display to indicate the calculated face velocity and actual exhaust airflow in CFM, plus setpoint parameters.

   B. The display shall provide the option to read in “Alpha” mode instead of numeric. The “Parameters” button on the face of the display shall allow the operator to scroll through all operating parameters and alarm setpoints, which shall be displayed on the LCD, including but not limited to:

      1. Controller Software Revision Number.
      2. Controller Output Level, %.
      3. Sash Position, %
      4. Calculated Face Velocity, FPM
      5. Exhaust Airflow Measurement, CFM
      6. High Airflow Alarm Setpoint, CFM
      7. Low Airflow Alarm Setpoint, CFM
      8. Low-Low Airflow Alarm Setpoint, CFM
      9. Operating Mode – Occupied, Unoccupied, Emergency/Fire Alarm

2.5 SUPPLY, EXHAUST AND FUME HOOD EXHAUST AIRFLOW CONTROL VALVES

   A. The Airflow Control Valve shall be CRC-Closed Loop Venturi valve or approved equal.
B. The Airflow Control Valve shall consist of a compression section, two airflow control surfaces, factory-mounted digital VorTek airflow measuring device and factory-mounted high speed actuator.

C. The compression section shall divide the airstream into at least two separate airstreams. Each airstream shall be approximately equal in size and the total open area shall be approximately 50% of the duct open area. The divided sections shall cause compression therefore creating a more laminar flow for better airflow measurement and turndown. The compression section shall be of an aerodynamic shape with a static regain section to insure minimal pressure drop. The valve shall not require any duct straight runs either upstream or downstream of the airflow valve to achieve required performance.

D. Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of 8 to 1.

E. The airflow control valve shall respond within one second of a change in duct static pressure when provided with factory controls.

F. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.

G. Valves for fume hood or other corrosive service shall incorporate phenolic coating on all aluminum and steel parts. Valves for non-corrosive service, such as supply air and general exhaust, shall be made of galvanized steel or aluminum.

H. Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of fume hood exhaust on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be field selectable fail-safe to either the open or closed position depending on the application. For airflow valves with linkage, springs, levers or bearings in the airstream access doors must be provided upstream and downstream of each and every damper for inspection of those devices for maintenance purposes.

I. All critical components of the airflow control valve shall be easily accessible from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy.

J. Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater than 0.25” pressure drop at 1500 fpm and 0.4” pressure drop at 2000 fpm. Airflow control valves that require higher pressures to operate shall not be acceptable.

K. The airflow valve shall be complete with a digital vortex type airflow sensing device providing true airflow feedback for the system. Airflow valves using mechanical means for creating pressure independence will not be acceptable. If an airflow valve such as a venturi valve is submitted that uses mechanical means for creating pressure independence such as springs and plungers, the valve manufacturer shall provide a 5 year service contract to the owner at no additional charge. The contract shall provide recalibration of the mechanical device using NIST traceable air stations and instrumentation having a combined accuracy of at least ±1% of signal over the entire
range of measurement. These mechanical devices shall be further calibrated and their accuracy verified to ±5% of signal at a minimum of eight different airflows across the full operation flow and static pressure range of the device. Service is provided twice annually for 5 years with complete service reports provided to the owner.

L. Airflow measuring devices shall be of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. A VorTek airflow sensor shall be provided in each chamber of the airflow control valve. Airflow measuring devices shall be capable of measuring velocity over the full range of 400 to 5000 FPM with a range up to 3” w.c. differential pressure. Pitot or Thermal Airflow sensors shall not be acceptable.

M. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars. Standard materials shall be manufactured of corrosion resistant CPVC and ABS.

N. Individual velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the airstream. The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.

O. Velocity measurements from individual sensors shall be summed in the associated Airflow Controller via integral Airflow Measurement circuitry or an integral Airflow Transmitter. The measurement shall be input and conditioned digitally to eliminate Analog-to-Digital conversion error. The airflow measurement shall be incorporated in the control sequence as performed by the Airflow Controller, and communicated to other Airflow Controllers, via the network, as required. Measurement system accuracy shall be plus or minus 2% of volumetric airflow rate. Turndown capability shall be at least 8:1.

P. Velocity sensing methods other than those specified shall not be acceptable. For another velocity sensing method to be considered it must provide the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal. If differential pressure devices are to be considered, dual differential pressure transmitters, the span of the lower transmitter being one tenth the span of the higher, with an accuracy not less than +/- 0.5%, shall be utilized to provide the required turndown. Orifice type devices shall have a Beta ratio of 0.7 or less, and shall be installed in accordance with ASME guidelines for up and downstream conditions.

Q. The airflow sensors shall be easily accessible in the valve for inspection.

R. Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.

S. Sensing methods employing thermal devices in the airstream shall not be acceptable due to their susceptibility to dust and dirt buildup in and exhaust airstream which could cause serious errors in readings and resultant safety issues in the laboratory.
T. Airflow Control Valve shall have factory installed electric actuator which shall operate on 24VAC. Actuator shall accept either a 4-20mA DC or 2-10VDC signal and shall modulate the valve over the range of CFM. The actuator shall modulate the valve between 0 to full scale CFM in less than 2 seconds.

U. Warranty shall commence upon the date of final completion of the project and extend for a period of twenty-four months whereupon any defects in materials shall be repaired by the supplier at no cost to the owner.

2.6 ROOM PRESSURE MONITOR AND CONTROLLER

A. Unit shall be CRC Room Pressure Monitors.

B. The controller shall include a touch-screen user interface, dp sensor and transmitter, and 4-20 mA output to BAS interface.

PART 3 - BUILDING AUTOMATION SYSTEM (BAS) INTERFACE

3.1 BUILDING AUTOMATION SYSTEM INTERFACE

A. The laboratory airflow control systems shall digitally interface BacNet to the Central Building Automation System (BAS) as provided by the temperature control contractor. The laboratory airflow control contractor shall be responsible to provide an interface device between the Laboratory Airflow Controls and the BAS, including standardized communications protocol software for BacNet and data mapping tables as required by the BAS design.

B. The following lab control parameters shall be transferred digitally to the BAS:

1. Emergency status.
2. Nite setback mode.
4. Calculated face velocity.
5. Hood exhaust airflow volume.
6. Hood exhaust airflow high alarm.
7. Hood exhaust airflow low alarm.
8. Supply airflow, CFM and setpoint.
9. General exhaust airflow, CFM and setpoint.
10. Airflow differential, CFM and setpoint.
11. Room temperature, setpoint.
C. The temperature controls contractor shall be responsible to provide digital interface devices, drivers for interfacing with ModBus protocols, software indigenous to the BAS, and graphic displays for the laboratory airflow control systems at the central BAS station.

D. Hardwire interfacing of lab control systems to BAS shall only be acceptable if:
   1. All parameters outlined in Paragraph B above shall be transferred to the BAS.
   2. The lab control contractor shall provide, in their Bid price, all additional equipment required on the part of the ATC for interface to the lab BAS systems, including ATC control panels.

PART 4 - EXECUTION

4.1 GENERAL

A. The laboratory airflow control system contractor shall functionally check all controls prior to setup by the test and balance contractor.

B. The laboratory airflow control system contractor shall assist the test and balance contractor in adjusting the setpoints to meet the specified airflow, pressure and temperature setpoints.

C. It shall be the responsibility of the General Contractor to secure the room envelope sufficiently to maintain required pressure levels with the airflow volumes specified. The laboratory airflow control system contractor shall advise the General Contractor of any condition which might compromise the ability of the room to achieve the specified pressure levels.

D. All dampers shall be fast-acting in operation without any sticking or binding.

E. All controls shall operate without cycling or hunting.

F. The laboratory airflow control system contractor shall demonstrate to the Engineer and/or Commissioning Agent the ability of the controls to maintain setpoints in all modes of operation.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe
B. Fittings
C. Valves
D. Pipe support devices
E. Pipe sleeves
F. Fireproofing of pipe and duct penetrations.

1.2 RELATED DOCUMENTS

A. Division 7 - Firestopping
B. Section 221000 – Plumbing, Piping and Valves
C. Section 230500 – Common Work Results for Mechanical
D. Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment
E. Section 230548 – Vibration Controls for HVAC Piping and Equipment
F. Section 230590 – Testing for HVAC
G. Section 230593 – Balancing for HVAC
H. Section 250000 – Building Automation System
I. Section 232114 – Hydronic Systems for HVAC
J. Section 232123 – Hydronic Pumps

1.3 SUBMITTALS

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. Pipe.
   2. Fittings.
   3. Valves.
   4. Pipe support devices.
a. Calculations for trapeze hangers.
5. Anchors and guides.
6. Pipe sleeves
7. Fireproofing of pipe and duct penetrations including UL listings and details.
8. Shop Drawings.
   a. See Section 230500 - Common Work Results for Mechanical.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. Valves.

1.5 REGULATIONS


PART 2 - PRODUCTS

2.1 ABOVE GRADE PIPE

A. Black Steel Up to and including 2" size: threaded black steel conforming to ASTM specifications A-53, Grade B, Schedule 40, complying with ASME B31.9 Building Services Piping.

B. Black Steel 2-1/2" and Over: ASTM A53 Grade B or A 120 ERW, Schedule 40, with welded connections, complying with ASME B31.9 Building Services Piping.

C. Galvanized Pipe: ASTM A53 Grade B or A 120 ERW, Schedule 40, complying with ASME B31.9 Building Services Piping, with rolled grooves for couplings. Hot dip pipe after grooving for complete galvanizing of the interior surface of the pipe.

D. Copper Tubing: ASTM B88, type "K", or "L", as specified, hard drawn deoxidized copper tubing for 2" and smaller piping as an alternative for chilled and heating hot water.

E. PVC: Schedule 80 PVC conforming to ASTM D1785 with solvent cement joints conforming to ASTM D2853.

2.2 FITTINGS

A. Nipples: All nipples shall be Schedule 80. Close nipples are not allowed.

B. Threaded Malleable Iron Fittings: ANSI B16.3, black, Class 150 (Class 300 for steam system) unless specified otherwise.
C. Soldered Fittings, for Copper Tubing: Wrought copper, ANSI Specification B16.22.

D. Welding Fittings: Black seamless steel, ASTM A234 Grade B, ANSI B16.9, same Schedule as pipe, butt-welding long radius type.

E. Cast Iron Flanges and Flanged Fittings: ANSI B16.9, 125 PSI. Black, unless specified galvanized.

F. Welding Flanges: Forged steel, ASTM A181 Grade II, ANSI Specification B16.5 flanges, Class 150, welding neck with 1/16" raised face, except where mating to flat faced valves or equipment, in which case flat face shall be used.

G. Flange Gaskets: Full faced or flat ring, to suit flange facings.
   1. Fluid Service: Garlock IFG-5500, Flexatillic, or equal.

H. Flange Bolting: Bolts, studs, and washers shall be carbon steel, ASTM A-307, Grade B, with heavy hex heads. Nuts shall be heavy hexagon series alloy steel, ASTM A-194, Grade B-7 or better. All bolts and nuts shall be cadmium or zinc plated.

I. Welding outlets: Grinnell, Weld-O-Let, or equal, forged welding outlets for butt welding or threaded connection as required. Use only for 2" and smaller outlets on 4" and larger pipes.

J. Unions for Steel Pipe: 2 inch and smaller in size, malleable iron, ground joint pattern, brass to iron seat, class 150. Unions over 2" in size, standard 150 PSI flanges with gaskets and bolts.


L. Brazing materials for any copper used for steam condensate and any other copper tubing 3 inches and over: 15% silver content, Engelhard Corp. Silvalloy-15, J.W. Harris Stay-Silv 15, or equal.

M. Solder for non-steam condensate copper tubing 2-1/2 inches and smaller: Engelhard Silverbrite 100R, Harris, or qual, 95-5 tin-antimony lead-free silver solder, with non-acid flux.

N. Copper to Ferrous Connections: Minimum 6 inch long schedule 40 brass nipples at threaded pipe. Flanges with gaskets and bolt isolator at welded and flanged pipes. Minimum 210 deg F at 250 PSIG rating.

O. Threaded to Solder Adapters: As specified for soldered fittings.

P. Escutcheon Plates: Chromium-plated brass plates with set screw to hold securely in place, installed on pipes passing through exposed ceilings, floors, and walls in visible locations.

R. Grooved Joint Piping Systems (Alternate for chilled water system)
   1. All grooved system components must be from the same manufacturer.
   2. Steel Pipe
      a. Grooved Joint Couplings to 12 inches: Victaulic 177 flexible (up to 8") and 77 from 8" to 12" or Victaulic 107 (up to 8") and 07 from 10" to 12" rigid grooved end joint couplings for steel pipe, and 606 rigid grooved end joint coupling for copper pipe, Central, Grinnell, Gustin-Bacon, or equal. Units shall be clamp-on and secured with two bolts rated up to 750 PSI. Gaskets shall be EPDM rated up 230 deg F service.
         1) Where use is required, use flexible couplings at rotary equipment and building joints, and where specifically shown.
         2) Where use is selected as an option to joining methods specified herein, use flexible couplings within 6 feet of pumps or other equipment, and use rigid couplings at other locations.
         3) Use only for chilled water system.
      b. Grooved End Pipe Fittings: Victaulic, Grinnell, Gustin-Bacon, or equal. Allowable items are limited to pipe, radius turns, tees, valves, and strainers. Strap-on tees, etc. are not allowed. Grooved piping system manufacturers must be ISO 9001 certified. Gaskets must be manufactured under ISO 9001 certification. Butterfly valves to be 300 psi rated, have bubble-tight shut-off, ductile iron, one-piece disc and stem, disc encapsulated with EPDM, ductile iron body with baked-on coating of poly-phenylene-sulfide, and tested of 10% above rated operation pressure under ISO 9001 certification.
      c. Flanges: Victaulic Style 641 Vic-Flange adapters conforming to ASTM A-536, direct connection with roll grooved pipe ends and fittings and with ANSI Class 125 cast iron and Class 150 steel flanged fittings and valves

2.3 VALVES
   A. Materials: In the following valve descriptions, iron means ASTM A-126 Class B, bronze means ASTM B-62.
   B. Manufacturers: Nibco, Stockham, Milwaukee or equal, except where another manufacturer is specifically named. In the following valve description the first model number is Nibco, unless another manufacturer is named.
   C. Check Valves 2" & Smaller in Size & Horizontal: T433B, threaded; 200 PSI WOG, Class 150.
   D. Check Valves Over 2" and Horizontal: F918-B, iron body, bronze trim, flanged, 200 PSI WOG, Class 125.
   E. Silent Check Valves over 2" Size or Vertical: F910, iron body, bronze trim, silent check valve, 200 PSI WOG, Class 125.
F. Globe Valves Over 2": F718B, iron body, bolted bonnet, bronze trim, flanged, 200 PSI WOG, Class 125.

G. Ball Valves 2 inches and Smaller: T-585-70 through 2-1/2 inches 2-piece construction, full port, bronze body with stainless steel or chrome plated brass ball, Teflon seats and packing, blowout-proof stem, 600 PSI WOG. Provide extended stem where required to clear insulation. Valves for the natural gas systems shall be AGA certified and UL listed.

H. Ball Valves 2-1/2 and 3 inches: T-595-Y 3-piece construction, full port, bronze body with stainless steel or chrome plated brass ball, Teflon seats and packing, blowout-proof stem, 600 PSI WOG. Provide extended stem where required to clear insulation. Valves for the natural gas systems shall be AGA certified and UL listed.

I. Butterfly Valves (2-1/2" and larger): LD-2000, Demco Series NE, or equal, with iron body, aluminum bronze ASTM B-148 alloy 9-C disc, Type 410 stainless steel stem and steel operating handle. All valves shall have full lug style bodies and extended stem so that handle clears the insulation. Valves shall have seven (7) positions to positively lock the valve disc against turning including a positive stop at "OPEN" and "CLOSED" positions. Butterfly valves for throttling and balancing service shall be complete with throttling handle capable of locking in any position from "FULL OPEN" to "FULL CLOSED", position indicator, marked dial plate, and built-in concealed set screw type memory stop. All valves shall have EPDM seats. Valve shall close bubble tight against 150 psig, 200 deg F. water. Valves shall be fitted between specified flanges and bolted with specified threaded studs, hex nuts and lock washers. All valves shall have a means of mechanically locking in final fixed position.

1. Where required, provide electric actuator suitable for tight shut-off against 150 PSIG water.
2. Butterfly valves for heating hot water system shall be carbon steel body, 316L stainless steel disc and stem, PTFE seats and seal, ANSI Class 150, minimum 250°F rated at the maximum operating pressure. Butterfly valves shall be Nibco LCS6822 or approved equal.

J. Lubricated Gas Cocks Over 2" size: Homestead 602, Nordstrom 115, or equal, lubricated semi-steel, 150 PSI, flanged (For 2" and under, use specified ball valves); AGA certified and UL listed.

K. Gauge Cocks: Use specified ball valves.

2.4 PIPE SUPPORT DEVICES

A. Pipe Hangers

1. All Sizes: B-Line, Grinnell, Superstrut, or equal, adjustable clevis hangers.
2. Use plastic coated hangers at all uninsulated copper piping.
3. Galvanized outdoors or inside air handlers.
B. Trapeze Supports: B-Line, Grinnell, Superstrut, or equal, 12 gauge channel complete with nuts, pipe clamps, pipe straps, and drive-on end caps. Furnish cushion strip on all uninsulated copper piping.
   1. Factory hot dip galvanized outdoors or inside plenum.

C. Pipe Supported Tight to Wall, Floor, or Ceiling: B-Line, Grinnell, Superstrut, or equal, 12 gauge channel complete with pipe clamps, nuts, bolts, and end caps. Furnish cushion strip on all uninsulated piping. Bolt to wall, floor, or ceiling.


E. Riser Clamps: B-Line, Grinnell, Superstrut, or equal. Provide additional neoprene rubber isolators at copper pipe to separate steel clamp and copper pipe.

F. Pipe Shields: Pipe Shields Inc., or equal (no known equal), pipe hanger shield with waterproofed calcium silicate insulation encased in a galvanized metal casing completely around the pipe, and bearing plate or integral 2-bolt hanger where required by specified model number. Provide insulation same thickness as pipe insulation.

<table>
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<th>12&quot;-18&quot;</th>
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<td>D3100</td>
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<td>A1000</td>
<td>A7200</td>
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</tbody>
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PART 3 - EXECUTION

3.1 GENERAL

A. Each mechanical device or equipment shown shall be provided with the correct supply, return, drain, vent, or any other piping necessary to operate the device or equipment. Branch piping from each device or equipment shall be connected to the nearest main service line with shut-off valves.
B. Each device or equipment shall be connected to the piping systems with either a union or flanged connection to allow for future removal.

3.2 PIPE

A. Pressure piping material, fabrication and support shall comply with ANSI B31, American National Standard Code for Pressure Piping, latest edition, including addenda.

1. If 5-inch pipe is not available, provide 6-inch pipe, fittings, valves, and accessories.

B. Use American Standard pipe threads for IPS threaded work. Use no caulking or packing of any kind. Ream out burrs formed by cutting tools and, before installing, examine each section of pipe to see that it is clean and clear. Pipes shall be free from tool marks. In making up screwed joints, apply specified thread lubricant to male threads only.

C. Slope all pressure piping (except industrial hot and cold water, domestic hot and cold water) minimum 1 inch in 40 ft. except where space conditions will not permit this slope. Slope water piping up in the direction of flow to high points and provide manual air vents as indicated and at all high points. Provide 3/4" ball valves and capped hose bibb connections at all low points for system drainage. Use eccentric reducing fittings to provide free drainage or venting of lines.

D. Wherever changes in sizes of piping occur, Use reducing fittings. The use of bushings will not be permitted.

E. Tee connections in either mixing or diverging flow will not be permitted.

F. Indirect Drain Piping: Install drains for all equipment requiring drains, full size of equipment connection or sizes as indicated on plans, and terminate over floor drain funnel, or floor sink as indicated and/or as directed. Provide and install all necessary pipe supports. Do not terminate on floor near floor drain funnel or floor sink. Slope 1/8" 1/48" per foot down to drain. Provide suitable traps in plenum areas. Provide 1" air gap between end of pipe and drain funnel. Route drains around normal access ways or as directed. Insulate entire piping route to prevent sweating. Insulate concealed or exposed condensate drain pipes within building, except floor mounted pipes in mechanical rooms. Provide clean outs at each change of direction.

G. Welding of Pipe Joints: Conform to the requirements of the American National Standard Code for Pressure Piping, ANSI B31, latest edition, including all addenda. Welding of piping may be made by either the electric-arc or gas-welding process. Use fittings in welded pipe specifically designed for welding. 45° and 90° turns shall be long radius type welded fittings. Make branches from welded mains to welded branches with radius welding tees except 2" and smaller branches on 4" and larger mains may be made with specified welding outlets. Make branches from welded pipe to screwed pipe with threaded welded fittings.

H. Qualification of Welders: All welders for work in this Section shall be certified welders. Certification shall be within the last five (5) years. Upon request, the Contractor shall
provide the Owner with the names of welders employed in the work, together with certification that each of these welders has passed qualification tests as prescribed by the National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency.

I. Install flange gaskets in strict conformance to the gasket manufacturer's recommendations including bolt pattern and torquing requirements.

J. Soldering and Brazing of copper tubing and fittings:
   1. Pipe, fittings, and valves charred or damaged due to excessive heating will not be permitted and shall be removed.

K. Install specified dielectric brass nipples or flanges at all connections of ferrous to non-ferrous systems. Dielectric unions are not allowed.

L. Carry all exposed and concealed horizontal lines of pipe on specified hangers properly spaced and set to allow the pipe to adjust for expansion and contraction. Use trapeze hangers for supporting groups of pipes. Piping in parallel shall be evenly spaced and supported.

M. Conceal all piping in furred walls, partitions, above ceilings, and pipe spaces except where specifically noted otherwise. Check all piping runs beforehand with all other trades. Run piping to maintain proper clearance for maintenance and to clear openings in exposed areas. Run piping in strict coordination with piping of other trades, ducts, and equipment, all electrical conduit and equipment, structural and architectural conditions, and work of other trades. Verify all inverts and pitched lines before starting work.

N. Install all exposed piping parallel to or at right angles with building walls and tight to walls, ceilings, or structure wherever possible, unless otherwise shown on the Drawings. Install all exposed overhead piping as high, and as tight to structure, as possible.

O. No valve, piece of equipment, or trim shall support the weight of any pipe.

P. Install all valves, vents, traps, cleanouts, trap primers, and other trim in accessible locations. Where shown on the Drawings, and where required, furnish access doors.

Q. Install all piping free from traps and air pockets and true to line and grade.

R. Where exposed pipes pass through walls, ceilings or floors, fit in all finished rooms and conspicuous locations with escutcheon plates. Escutcheon plates must be securely held in position allowing enough clearance to care for expansion and shall be of sufficient size to cover the opening around the pipe, or insulation.

S. Provide 3/4-inch drain with ball valve with hose adapter at the bottom of each riser.

T. Grooved Joint Coupling Systems:
1. Install only where specifically shown on Drawings or approved through the submittal process.

2. Install in accordance with manufacturer's recommendations.

3. Cut grooves are acceptable, all sizes.

4. Rolled grooves are acceptable for pipe sizes 2-1/2" and larger.

5. Only standard full flow, long radius fittings and specified couplings are acceptable. Clamp-on, drilled-in tee connections are specifically prohibited.

6. Use specified grooved, threaded, and flanged valves. Install specified weld neck flanges at flanged valves and equipment.

7. Where flexible couplings are used, rigidly support and laterally brace each section of pipe to prevent movement. Submit full shop drawings indicating all supports and braces.

8. Where flexible couplings are used at building expansion joints, provide anchors on either side of expansion joint.

U. Provide for expansion and contraction

1. Place piping without spring or forcing unless specifically indicated.

2. Provide flexibility, anchors, guides, and supports to prevent strain from thermal movement or weight from being imposed on equipment. Include thermal expansion compensation control for all steam and condensate pipes regardless if specifically shown or not on the drawings.
   a. Submit documentation indicating compliance.

V. Pipe Penetration Sealing

1. Where firestopping is not required, seal pipe penetrations with GE silicone sanitary sealant, Dow Corning 8640 Interior Sealant, or equal, at wall, ceiling, and interstitial deck locations.

2. Seal exposed pipe penetrations through walls, ceilings, and floors in all finished rooms and conspicuous locations with escutcheon plates. Escutcheon plates shall be securely held in position, allowing enough clearance to care for expansion and shall be of sufficient size to cover the opening around the pipe or insulation.
   a. Notify Owner Representative prior to installing escutcheons for inspection and approval of sealing and packing.

3. Waterproofing Sleeve Assemblies: Prepare penetration opening and install waterproofing assembly in annular space between pipe and opening as recommended by the unit manufacturer.

W. Pipe all exhaust fan scroll drains to designated waste systems.

2. Wet Exhaust: Sanitary sewer. Use copper "L" piping.


X. Provide thermowells and tap-ins for all thermometers, temperature sensors, pressure gauges, and pressure sensors.

3.3 VALVES

A. Application: Where valve type is not specifically indicated on Drawings, use ball valves for shutoff service in sizes 2" and less. Use globe or ball valves for throttling service, size 2" and less. Use globe valves for shutoff and throttling, sizes 2-1/2" and larger. Use butterfly valve for liquid shutoff services, sizes 2-1/2" and larger.

B. All valves, unless specifically sized, shall be of the same sizes as the pipe lines in which they are installed. No valve shall be installed with its stem pointing below the horizontal unless specifically shown otherwise. Install globe valves to close against the pressure. Install a union adjacent to every screwed valve, where required for disassembly, and where shown. At natural gas systems, provide right and left nipples and couplings.

C. Provide union downstream of each threaded valve, except at natural gas systems, provide right and left nipples and couplings.

D. Handwheel Operated Valves: All butterfly valves 8 inches and larger shall have gear operated handwheels.

E. Chain Operated Valves: Install where valves are 4" or larger and cannot be operated from the floor. Chains shall hang to 5'-0" above the floor and shall be galvanized. Provide hooks to raise chain up to 7'-0" or higher, when not in use.

F. Valve Tags: See Section 230500 – Common Work Results for Mechanical.

3.4 PIPE SUPPORT DEVICES

A. Support Schedule:

B. Schedule of Hanger Rods and Spacings for Single Pipe Support

<table>
<thead>
<tr>
<th>Pipe Size Inches</th>
<th>Rod Size Inches(2)</th>
<th>Spacing-Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Steel Pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copper Tubing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cast Iron Pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic Pipe</td>
</tr>
<tr>
<td>1 &amp; Smaller</td>
<td>3/8</td>
<td>7</td>
</tr>
<tr>
<td>1-1/4</td>
<td>3/8</td>
<td>8</td>
</tr>
<tr>
<td>1-1/2 - 2</td>
<td>3/8</td>
<td>9</td>
</tr>
<tr>
<td>2-1/2 - 3</td>
<td>1/2</td>
<td>10</td>
</tr>
</tbody>
</table>

Ratcliff Project 35003.01 DSA Approval March 21, 2018
Addendum 2 – April 26, 2018
4 - 6 1/2 10 10 5 --
8 5/8 12 -- 5 --
10 3/4 12 -- -- --
12 7/8 16 -- -- --
14-16 1 20 -- -- --
18-20 1-1/4 25 -- -- --

(1) Furnish and install continuous channel piping support, and/or additional supports in accordance with manufacturer's directions.
(2) Increase rod size when required by seismic bracing criteria.

C. Support pipes at intervals indicated in schedule above, and at each change of direction.
D. Every branch of piping over 3 feet long shall have a separate hanger.
E. Use specified clevis hangers and pipe shields (if applicable) at single pipe supports.
F. Multiple pipes may be supported on a common trapeze. Use specified pipe shields (if applicable). Trapeze size, and support size and spacing shall be governed by the cumulative weight of the supported piping. Maximum trapeze deflection shall be 1/360th of the span on a maximum stress of 10,000 PSI, whichever is more stringent. Provide calculations for each trapeze.
G. Support high temperature heating hot water, steam, and condensate piping 4” and over using specified saddle, yolk, and roll assembly.
H. In certain cases piping is to be supported from below. Provide all stands, supports, braces, trapeze, etc., required.

3.5 PIPE ANCHORS:

A. Above-ground thermal expansion control. Provide anchors where indicated and where required for thermal expansion control. See drawings for details.

3.6 WATER SYSTEM LEAK TESTING

A. See Section 230590 – Testing for HVAC.

3.7 PIPE SEISMIC BRACING

A. See Section 230529 – Hangers, Supports, Anchors, and Seismic Restraints for HVAC Equipment.

3.8 VIBRATION CONTROL

A. See Section 230548 – Vibration Controls for HVAC Piping and Equipment.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. All duct systems related to heating ventilating and air conditioning as indicated on the Drawings and specified herein. Provide complete, continuous, operational, and functioning systems, fully coordinated with work of other Sections.

B. Work includes, but is not necessarily limited to, the following:
   1. Ductwork
   2. Duct accessories
   3. Sound traps
   4. Fire barrier duct wrap
   5. Reheat coils
   6. Air Inlets and outlets
   7. Flue for water heaters
   8. Installation of duct smoke detectors and other sensors mounted on or in ductwork

1.2 RELATED DOCUMENTS

A. Section 230500 – Common Work Results for HVAC
B. Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment
C. Section 230548 – Vibration Controls for HVAC Piping and Equipment
D. Section 230700 – HVAC Insulation
E. Section 230590 – Testing for HVAC
F. Section 230593 – Balancing for HVAC
G. Section 237300 – Air Handling Units
H. Section 250000 – Building Automation System
I. Division 26 - Electrical: Smoke detectors

1.3 SYSTEM DESCRIPTION

A. Medium pressure ductwork (6” w.c.) includes:
1. All exhaust ductwork connected to fans with scheduled static pressure exceeding 2.5" 2" water column.

2. All supply ductwork upstream of airflow control (or VAV) terminals or reheat coils.

3. Other ductwork noted or specified as medium pressure construction.

4. All roof mounted ducts.

5. Fume hood exhaust ducts, combined fume exhaust and lab general exhaust in lab building.

B. Low pressure ductwork (2" w.c.) includes:

1. All galvanized ductwork downstream of airflow control (or VAV) terminals and reheat coil, horizontal toilet exhaust duct, and ducts not included under medium pressure ductwork above.

2. General exhaust between exhaust grilles and airflow control terminal units.

C. Stainless Steel Ductwork: Stainless steel construction conforming to medium pressure standards.

D. Ductwork Construction Schedule

<table>
<thead>
<tr>
<th>System</th>
<th>All welded Min. 16 ga. 304 Stainless Steel</th>
<th>Galvanized Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fume Hoods Exhaust branch directly connected to fume hoods</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Gas Storage Cabinet Exhaust</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Wet Exhaust – Shower, Sterilizers, Glasswash</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Radioisotope Exhaust</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>General Exhaust</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Supply and Return Duct</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Countertop Slot Hood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Fume Hood and Lab General Exhaust</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Canopy Hood</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

E. Duct pressure classification shall be as specified herein and not as recommended in SMACNA publications.
1.4 SUBMITTALS:

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for HVAC.

1. Ductwork.
2. Duct accessories.
3. Sound traps.
4. Duct mounted reheat Coils
5. Air inlets and outlets.
6. Shop Drawings:
   a. Duct reinforcement and construction schedules.
   b. Duct support details.
   c. Detailed duct shop drawings at 1/4” - 1'-0” scale in accordance with Section 23 05 00 – Common Work results for Mechanical, of all mechanical rooms, riser elevations, and floor plans.
7. Written program outlining protection of ductwork from contamination with dirt and procedures for cleaning contaminated ductwork.
8. Samples
   a. Stainless Steel Welding Specimens: Provide hand-welded and machine-welded specimens of each gauge of welded stainless steel exhaust duct and plenum. Samples shall be 10” diameter and 10” x 10” rectangular showing the joining of round duct sections as will be done in the field. Submit detailed description of weld techniques, including method, shielding gas, gas rate, filler metal and size, filler feed rate, welding current and voltage, and welding speed.

1.5 REGULATIONS

A. U.L. Label: Fire dampers, insulation and sealants, flexible duct.
B. Unless otherwise noted comply with SMACNA HVAC Duct Construction Standards, latest edition.
E. A.D.C. Certification: Performance and Acoustic Data for air inlets and outlets.
F. NFPA 90A.
PART 2 - PRODUCTS

2.1 GENERAL

A. Capacity and Performance: See drawings for nominal selections.
   1. Provide necessary calculations for correct sizing of the equipment for the specific applications.

2.2 DUCTWORK:

A. Sheet Metal for Ducts: G90 galvanized steel sheets conforming to ASTM A-525 and A-527, lock-forming grade, of gauges as specified hereinafter, except where another material is specifically indicated. See PART 3 - EXECUTION - DUCTWORK, and drawings for duct construction requirements.

B. Chemical cabinet exhaust:
   1. Where chemical storage cabinets exhaust is 2-1/2 inches or smaller, use 16 gauge 304 SS all welded stainless steel tubing.
   2. Where chemical storage exhaust is 3 inches and larger, conform to fume exhaust duct requirements above.

C. Flexible Ducts for Supply Diffuser Inlets: Shall be Flexmaster, or equal. Ducts shall consist of an inner liner made from a fiberglass reinforced coated film laminate permanently bonded to a corrosion resistant coated steel wire helix. There shall be no insulation in contact with the air stream. Insulation shall be 1-1/2 inch thick fiberglass blanket with a minimum R value of 4.2 HR/deg.F/FT²/BTU at 75 deg.F differential. Outer vapor barrier shall be a polyethylene or a fiberglass reinforced metalized jacket. Operating pressure rating shall be 2 inches w.g. Size equal to terminal inlet connection. Compression clamp bands shall be galvanized steel screw-on type on nylon strap type utilizing a special compression tool. Maximum flame spread shall be 25, and maximum smoke developed shall be 50. Table below indicates rated sound attenuation for stated length. See Part 3 – Execution for installed length requirements.

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length</th>
<th>Flow Band</th>
<th>DIL-dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inches</td>
<td>9 Ft.</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>8 inches</td>
<td>9 Ft.</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>12 inches</td>
<td>9 Ft.</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

2.3 DUCT ACCESSORIES:

A. Duct Flexible Connections for Interior Applications: Ventfab #3002, Elgen SDN-4, or equal, neoprene coated fiberglass fabric applied according to manufacturer's recommendations. Provide sheet metal bands or metal-edged fabric.
B. Duct Flexible Connections for Outside Applications and at Fume Exhaust and Wet Exhaust Fans: Ventfab "Ventlon", or equal (no known equal), teflon and neoprene coated fiberglass fabric applied according to manufacturer's recommendations. Provide flanged stainless steel-edged fabric or strap to ducts and fan inlets with stainless steel screwdriver adjustable bands.

C. Duct Access Doors: Ductmate Sandwich, Ward Industries, Air Balance, Ventlok, or equal, access doors, with gaskets and compression latches, models as listed below. Doors shall be 18" x 14" minimum unless otherwise shown or in limited space. Provide where shown and where required for access to any operable device installed under this Section. Provide edge protection at cut openings. Doors in supply ducts shall leak not more than 0.5 CFM per 18" x 14" door at 6" W.G. differential pressure. Include leak test data in submittals. See duct leakage test specified hereinafter.

2. Duct access doors in plenums as shown on the Drawings.
3. Duct access in stainless steel ducts shall be fabricated from the same stainless steel material as the ductwork.

D. Barometric Backdraft Dampers:

1. General Fan Service: Ruskin CBS8, Air Balance Inc., or equal. Units shall have 8" x 2" x 10 gauge galvanized steel channel frame, 18 gauge airfoil blades, 3/4 inch diameter steel axles, externally replaceable ball bearings, linkage and counterweights outside of the air stream, adjustable counterbalance, and be designed to withstand a static pressure of 8" w.g. up to 3,000 FPM. Pressure drop shall not exceed 0.18 in. w.g. at 1,000 FPM.
2. Stainless Steel Exhaust Duct Service: Same as for fan service above except material shall be 316L stainless steel. Damper frame at AE-1 to have weep holes.
3. General Duct Service: Counterbalanced Backdraft Dampers: Ruskin CBD4, Acme, Air Balance, or equal, counterbalance backdraft damper with minimum 0.09 inch thick aluminum frame, 0.025 inch formed aluminum blades with extruded vinyl edge seats and 1/8 inch x 1/2 inch aluminum bars concealed in frame.

E. Volume Dampers:

1. Multi-Blade Dampers: 16 gauge galvanized steel blades with maximum blade width 6", 1/2" diameter steel continuous shafts in bronze bearings and 1-1/2" x 1/2" x 1/8" welded structural steel channel frames. Dampers shall be opposed blade with other details as shown in Sheet Metal and Air Conditioning Contractors' National Association "HVAC Duct Construction Standards", First Edition, 1985, Fig. 2-15. Manual Operating Quadrants: Ventlok #641 with #609 end bearing, Elgen, or equal, with gaskets. Saw cut shaft end 1/16" deep parallel with damper blade. Size and install dampers with their frames outside of the air stream.
2. Single Blade Dampers: 18 gauge galvanized steel 12" maximum width blade, with V-crimp at edge and center of blade. Dampers shall have 3/8" continuous square steel shafts with operators and end bearing as specified above. Other details shall be as shown in Sheet Metal and Air Conditioning Contractors' National Association "HVAC Duct Construction Standards" Fig. 2-14A, round dampers shall be similar with V-crimp at edge omitted. Saw cut shaft end 1/16" deep parallel with damper blade.

3. Where access to damper operators on ducts is not possible, such as hood ceiling areas, provide remote operators, Ventlok #666, Elgen, or equal, with paintable finish steel cover and screws and waterproof gasketing. Cover shall be oversized to lap finished surface 3/8" all around. Provide extended control rods and/or Young #917, Ventlok #680, or equal, miter gears for making right angle turns. Submit samples. Cable type operators are not acceptable.

4. Single Blade Stainless Steel Round Dampers (Fume Hood, Radioisotope and Wet Exhaust):
   a. Dampers shall be welded stainless steel 316 damper with 16 gauge by 8" long rolled frame, 16 gauge by 1 inch wide flange at both ends with pre-drilled 1/4 inch bolt holes spaces at 30 degrees apart minimum, 16 gauge 304 stainless steel shaft welded to damper blade and extends 6 inches outside, 304 stainless steel sleeve bearings pressed into frame, blade stops welded to frame at 60 degree intervals, notched end of damper shaft to indicate damper blade position.
   b. Damper frame, flanges, blade stops, blade, shaft, and bearings shall be stainless steel 304.
   c. Damper shall equip with Durodyne Stainless Steel 304L System locking quadrant system, or equal. Tack weld quadrant and bearing to duct.

5. Manual operating quadrants: DuroDyne Spec-Seal or equal (no known equal), air tight, zero leaks, rattle-free damper regulators.

F. Low leakage Dampers – Motorized

1. For general exhaust, economizer cycle and isolation:
   a. Ruskin CD-60, Air Balance, Inc., or equal. Units shall be steel construction with 16 GA x 5" frame, opposed 16 GA x 6" airfoil blades, concealed damper linkage, vinyl damper seals, bearings and bearing seals, and end switches to monitor full open and full closed positions. Pressure loss shall not exceed 0.12" w.g. when passing air at 2000 FPM velocity. Air leakage shall be less than 4.2 cfm/sf when shut off against 4" w.g. pressure differential. Each section of a damper bank shall be no larger than 60" x 40" maximum. All linkages shall be ganged together except as noted. Provide one damper motor for approximately each 16-square foot section of damper and one for the minimum outside air section (if applicable), each operating on a separate shaft. Size actuators to provide maximum torque acceptable to the damper.
1) Size dampers sections and provide damper bank reinforcing for larger damper sections for operation up to 7" w.g. differential pressure.

G. Turning Vanes
1. Galvanized steel ductwork; galvanized steel or painted black steel, except as indicated on the Drawings
2. Other ductwork: same material as ductwork
3. Construction per SMACNA HVAC Duct Construction Standards for
   a. Single wall vanes with ¾ inch trailing edge
   b. Double wall vane: Not acceptable
   c. Vane length: Provide separate equal size sections for vane length greater than those indicated in referenced Standards
   d. Vane runners: Type 1 or 2 acceptable

4. Vane radius
   a. 2 inch radius: duct width up to 36 inches
   b. 4 inch radius: duct with 36 inches or larger

5. Vanes shall be at the correct angle for airflow (leading edge in line with the entering duct section; leaving edge in line with exiting duct section). If only 45 degree angles are available, turning vanes shall only be used in 90 degree elbows where the entering width equals the exiting width; all other elbows shall be full radius type unless otherwise indicated on the drawings.

H. Duct Sealant:
1. United Duct Sealer, 3M #800, or equal, non-flammable, U.L. labeled.

I. Gasket Material:
1. For non-fume exhaust duty: Tremco 440, Ductmate 440, or equal, minimum 3/16" thick by 1/2" wide.
2. For fume exhaust duty: See Part 3 - Execution hereinafter.

2.4 SOUNDTRAPS (ATTENUATORS)

A. Acceptable Manufacturers: Vibro-Acoustics, Industrial Acoustics Company, United McGill, Rink, or equal.

B. Performance:
1. Acoustic Performance:
   a. Ratings are to be determined in a duct-to-reverberant room NVLAP accredited test facility which provides for airflow in both directions through
the test sound trap in accordance with ASTM Specification E 477, latest edition. The test set-up and procedure is to be such that all effects due to end reflection, directivity, flanking transmission, standing waves and test chamber sound absorption are eliminated.

b. Acoustic ratings are to include Dynamic Insertion Loss (DIL) and Self-Noise (SN) Power Levels for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite directions) at approximately the design conditions for the specific applications.

c. The engineer-of-record is to provide specific selections, based on the acoustic consultant's directions, to meet the specified criteria.

1) Provide appropriate soundtraps appropriate for the service intended.

2) Provide custom modifications needed.

3) Sound traps indicated on the drawings are nominal. Provide sizes, attenuation, and pressure drop performance to meet sound and energy criteria.

2. Aerodynamic Performance:

a. Airflow measurements shall be made in accordance with ASTM Specification E 477, latest edition and applicable portions of ASME, AMCA, and ADC airflow test codes, latest editions.

b. Small increases from the scheduled values are acceptable. Submit for review.

C. Certification: Provide certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance for reverse and forward flow test conditions. Test data shall be for a standard product.

D. Packless Sound Traps with liner:

1. Construction

a. Same as for Packed Sound Traps without liner except filler is sealed inside a polymer sheeting. Polymer sheeting shall be non-erosive, non-pregnable Tedlar of approximately 1.5 mils thickness and shall completely cover all fill. The encapsulated fill shall be separated from the interior perforated baffles by a factory installed ½” thick acoustically transparent spacer. The spacer shall be flame retardant and erosion resistant. A mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.

2.5 INTERNAL ACOUSTIC INSULATION

A. Owens-Corning Aeroflex, Certainteed or equal, made of long glass fibers with a flexible, black, abrasion resistant coating. If internal insulation is shown on the drawings, then external insulation is omitted.
   1. 3 lb. density.
   2. Thickness: One inch thick at all other locations unless otherwise indicated.
   4. Install only where specifically shown on the drawings.

B. Joint Sealant: Glass cloth and Arabol E1658B, Foster 30-36, or equal UL listed product.

2.6 DUCT MOUNTED COILS (HEATING HOT WATER COIL, CHILLED WATER COIL, HEATING HOT WATER & CHILLED WATER COIL MODULE)

A. COILS
   1. Coils shall be manufactured by Energy Lab, Temtrol, Trane, or approved equal. Install coils such that headers and return bends are enclosed by coil module casings.
   2. Construct coils of configuration plate fins and seamless tubes. Fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.
   3. Construct coil casings of minimum 16 gauge type galvanized steel with formed end supports and top and bottom channels.
   4. Coil modules shall be double-walled, internally insulated construction with interior constructed of 18 gauge, 304 stainless steel and outer material constructed of 16 gauge, galvanized steel. Construct coil casings with formed end supports and top and bottom channels. Provide insulation within double wall construction on all four sides, including the condensate drain pan.
   5. Internal insulation shall be minimum 1 inch, 3 pounds per cubic foot density, with thermal conductivity (k value) of 0.26 at 75 degrees F mean temperature. Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
   6. Provide mock-up of sample chilled water/heating hot water coil module for Engineer’s and Owner’s review.
   7. Coil Modules (Lab Wing VAV Zone Cooling and Heating Application): Acceptable manufacturer: USA Coil, RAE, or approved equal.
   a. Heating Hot Water Coils (See equipment schedule for coil modules specified with heating hot water coil)
1) Clearly label supply and return headers on outside of units such that direction of coil water-flow is counter to direction of unit air-flow.

2) Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.

3) Construct headers of non-ferrous, seamless copper.

4) Construct tubes of 1/2 inch O.D. minimum 0.020 inch thick copper and construct fins of aluminum. See equipment schedules for further details.

b. Chilled Water Coil

1) Chilled water coils shall be of the plate fin extended surface type and ARI 410 certified for water. The primary surface shall be a minimum of 5/8" outside diameter, unless noted in the schedule otherwise, seamless copper 0.020" minimum wall thickness, and shall be expanded into the fin collars to provide a permanent mechanical bond: no metallic or thermal bonded materials shall be used. The secondary surface shall be flat or formed of 0.008" aluminum fins. All coils shall be constructed with .025" thick brazed replaceable return bends. Same end connections are required. Headers shall be non-ferrous seamless copper, and provided with tobin bronze brazed copper male pipe connections and separate 3/8" diameter pipe vent and drain connections extended through unit casing. All coils shall be fully drainable with no trapped tubes by design. All coils shall be counterflow construction, with connections left or right hand as specified on the drawings. The use of internal restrictive devices “Turbs” to obtain turbulent flow will not be accepted. Spiral fin coils are not acceptable on any dehumidification coils unless face velocity is kept under 350 FPM. All copper to copper joints shall be made with high temperature brazing material: no pressure bonding or roller expanded bonding shall be used.

2) Coil casings shall be minimum 16 gauge, 304 stainless steel internal with double formed 3/4" flange on all sides of coil with tube sheets having extruded tube holes. Coil casing reinforcements shall be furnished so that the unsupported casing length is not over 60°. Reinforcements shall be made of same material as coil casing.

3) All tubes shall be tested at a minimum of 1500 PSIG and all assembles tested under water at 350 psig and rated for 180 psig working pressure. Provide plates at both ends of the coils to divert the condensate drip from the headers and return bends into the drain pan.

4) The coils shall be arranged for easy removal by means of 16 gauge stainless steel rail rack on which the coil is mounted. The end of the coils shall be carefully blanked off with 16 gauge
stainless steel to insure all of the air passes through the coils. Intermediate condensate pans are to be furnished on stacked coil units to prevent upper coil condensate from passing over the lower coil. Intermediate drain pans are to be fabricated from the same material as the primary drain pan. Stainless steel intermediate drain pans shall have 1” copper down spouts. The water headers shall be located inside the cabinet casing with only the connecting pipe stubs extended through the cabinet.

c. Double Sloped Condensate Drain Pans
1) Provide a 304 stainless steel condensate drain pan for chilled water coils of deep, double sloping design which slopes in 2 directions (downstream from cooling coil and also toward the outlet side. The drain pan shall slope 1/8” per foot toward drain connection and be placed under the entire coil section and extend in the direction of air flow a minimum of 6” beyond the leaving edge of the coil. Entire drain pan shall be easily accessible for annual inspection and cleaning.

2) The coil module shall have a minimum 3/4” M.P.T. primary drain, or size per Uniform Mechanical Code based on coil capacity and 3/4” overflow drain connection, unless otherwise noted, on same side of unit as coil connections. The drain connection shall be fabricated with same material as main drain pan and connection shall be installed below the bottom of the drain pan. The overflow drain shall have a threaded outlet for connection to condensate monitoring by controls.

d. Double-walled Construction Cabinet
1) The unit shall be of double walled construction, which includes 16 ga. galvanized steel exterior cabinet and 304 stainless steel interior solid liner. Provide 2” thick insulation for all four sides, including bottom panel below drain pan. Minimize lap joints in the cabinet construction.

2) Provide factory hanging bracket for overhead support and bracing installation.

3) All piping through wall connections shall be sealed.

2.7 AIR INLETS AND OUTLETS

A. Manufacturers: Titus, Air Factor, Krueger, Metalaire, or equal. Model numbers below are Titus unless otherwise noted.

B. Performance, neck size, and overall size as shown on the drawings.

C. Frame: As required for intended ceiling or wall installation. Provide drop face where used with drop-face or tegular ceiling tiles.
D. Color: As directed.

E. Performance and Acoustic Data: Per ADC Equipment Test Code 1062 and ASHRAE 70.

F. Dampers: Provide a duct mounted volume damper for each device unless specifically noted otherwise. Opposed blade dampers at the inlets and outlets are not required, unless shown on the Drawings.

G. Air Supply Devices:

1. Perforated plate diffusers
   a. PAS, steel, with removable aluminum face plate, and adjustable pattern controllers, capable of radial 4-way, 3-way, 2-way, or 1-way blow. 24" x 24", 20" x 20", 16" x 16", or 12", x 12".
   b. TriTec or equal (no known equal). Low velocity 1- or 2-way blow hemispherical distribution diffuser with 51% free area 304 stainless steel perforated faceplate with aluminum back-pan. The face, lower air chamber, directional blades, and pressure induction plate shall be one assembly removable from the face of the unit. The perforated face shall not hang more than 5/8" below the ceiling. 24" x 48" with 12" round inlet or 24" x 24" with 10" round inlet. All room side surfaces to have a mill finish with no visible weld marks, discoloration, or scratches.
   c. Note that the architectural ceiling surrounding the diffusers has been selected to match the pattern of the specified diffuser. Verify that the patterns match.
   d. Aluminum Spot Diffuser: Seiko Model PK and PK-E aluminum diffusers with rotatable body, adjustment knob, neoprene mounting gasket. Provide unit with integrated damper when no volume damper is shown on branch duct on drawing.

2. Sidewall Registers:
   a. 272RL, register with steel border and 2 sets of 3/4" adjustable aluminum airfoil blades. Front blades shall be parallel to short directions, rear blades shall be parallel to long dimension.

3. Slot Diffusers:
   a. Flow Bar Series, heavy wall extruded aluminum slot diffuser with black painted interiors and integral pattern controllers with either the High Throw or Jet Throw option as applicable. Provide concealed frames for gypboard installation.
   b. Provide fabricated or factory furnished internally lined plenums behind the diffusers. If plenums are fabricated, verify net inside dimension and requirements for internal pressure equalizers, deflector vanes, etc. with the manufacturer.
   c. Provide all connectors, end caps, blank-offs, etc.
H. Air Exhaust Grilles:
   1. PAR, similar to supply diffuser but without pattern controllers.
   2. 25RL stainless steel register with 30 deg blades spaced 1/2 inch apart.

2.8 FACTORY BUILT FLUES (NON-CONDENSING EQUIPMENT)

A. Metalbestos, RV, AMPCO, Van-Packer, or equal, double wall Type B vent Category IV, U.L. listed for use with building for condensing heating equipment as described in NFPA 211.

B. See Section 2-3.4 232204.

C. Outer wall shall be galvanized construction and inner wall shall be aluminum.

D. Fittings, Couplings, Supports, Guides, Flexible Connections, and Weatherproof Terminations: Of same manufacturer as the double wall system, and covered under the U.L. listing.

PART 3 - EXECUTION

3.1 DUCTWORK

A. Where not otherwise specified herein, shown, noted, or required by codes, work shall conform to "HVAC Duct Construction Standards, Metal and Flexible," latest edition, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc., (SMACNA).

1. 6" w.g. class for herein specified medium pressure ductwork.
2. 2" w.g. class for herein specified low pressure ductwork.

3.2 DUCTWORK CONSTRUCTION

A. Duct Placement and Fittings:

1. Form transitions with uniform taper not exceeding 15 degree included angle, unless shown otherwise on Drawings.
2. Offsets over 15 degrees shall have two radius turns or square turning vanes.
3. Where it is not possible to insulate ducts after installation, ducts shall be insulated before final installation. Tightness of work will not be accepted as a valid reason for omitting any insulation. Where insulation is omitted, ducts will be removed, insulated and reinstalled.
4. Exposed Ducts: Exercise extreme care to produce neat and pleasing-in-appearance joints, connections, supports and other modifications. Ducts shall have no offsets, dents or dings. They shall be clean and grease-free. Remove
all excess sealant. Appearance must be acceptable to the Owner's Representative.

5. Install ducts true to line and grade.

6. Make changes of direction by curved sections with inside radius equal to duct width or square elbows with turning vanes as shown; for tight spaces, elbows with inside radius equal to half or quarter are allowed. No square elbows are allowed for exhaust.

7. Closely fit and accurately place ducts and coordinate with work of other trades. Ducts must be so placed that piping, ceiling support grid, ceilings, and light fixtures may be installed without warping, springing or deforming ducts.

8. Attach specified joint reinforcement and intermediate stiffener angles to ducts with 3/4" long welds or 3/16" diameter rivets 12" on center unless indicated otherwise.

9. Angles and standing seams on ducts exposed in occupied areas shall have the corners chamfered 45 deg with 1/4" rounded edges and ground smooth.

10. Seal all duct penetrations through walls and floors at Vivarium for vermin proofing.

11. Provide inlet and outlet duct transitions at reheat coils, constant, variable, and air flow control terminal whether or not such transition is shown on the drawings. Coordinate work with electrical.

12. Closely coordinate roof penetrations with architectural details.

B. Low Pressure Rectangular Ductwork (2" w.c.):

1. Longitudinal seams: Flat crimped Pittsburgh lock with internal RTV Sealant, 3M #800, 4" Hardcast tape, or equal, applied over seam.

2. Transverse Joints: Ductmate 35, TDC, or equal with specified gasket.

3. Cross break or bead all sides.


C. Medium Pressure Rectangular Ductwork (up to 6" w.c.):

1. Longitudinal seams: Same as for low pressure ductwork.

2. Transverse Joints Ductmate 35, TDC, or equal, with specified gaskets.

3. Cross break or bead all sides of ducts.

4. Seal flanged joints, companion angle joints, and Ductmate joints with specified gasket material, triple lapped at corners. Torque bolts evenly to 1/16".

5. Construction and Reinforcement: Per SMACNA standards.

D. Round Ductwork - HVAC:
1. Provide spiral round ductwork where shown on the drawings.

2. At the Contractor’s option round ducts up to and including 20 inches in diameter may be substituted for rectangular ducts provided that the cross sectional area of the round duct is equal to or greater than the rectangular duct. As with other substitutions the contractor bears all responsibility for equivalency, fit, clearances, coordination, etc.

3. Duct Gauges:

<table>
<thead>
<tr>
<th>Size</th>
<th>Low Pressure</th>
<th>Medium Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thru 8&quot;</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>9&quot;-14&quot;</td>
<td>26</td>
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<tr>
<td>14&quot;-26&quot;</td>
<td>26</td>
<td>24</td>
</tr>
</tbody>
</table>

   a. Low Pressure:
      1) Elbows: 26 gauge smooth. Pleated not allowed.
      2) Adjustable Elbow: 26 gauge Uniweld. Spot welded and sealed joints (only allowed at tight locations).
   b. Medium Pressure:
      1) Elbows: 24 gauge die-stamped. All welded joints.
      2) Other: 24 gauge uniform spot welded, and sealed. All welded joints.
      3) Elbows: Radius to center of duct shall not be less than 1.5 times the diameter of the duct.
      4) Reducers: Machine formed to ASME short flow nozzle shape.
      5) Tees: Conical tap machine formed to short flow nozzle shape.
      6) Laterals: Machine formed to ASME short flow nozzle, conical tap at 45 deg F.
      7) Round tap fittings: Saddle type for round duct or conical for rectangular ducts as shown on the Drawings.

5. Round Duct Joints: Join by means of couplings with swaged bead in center and secured with sheet metal screws at each end of coupling. Make duct-to-fittings joints by either a tight slip fit of the fitting lapped inside the duct or by means of couplings with swaged bead in center, all secured with sheet metal screws. Screw spacing: 6", unless otherwise shown on the Drawings. Seal joints and seams with 4" wide Hardcast tape or specified internal sealant applied continuously around the coupling.

E. Fume Hood Exhaust, Radioisotope, Exhaust, and Wet Exhaust Ducts:

1. Stainless Steel Construction:
a. United McGill Corporation, Western Engineering, or equal, prefabricated, seamless 304 stainless steel round duct with minimum 16 gauge. Shop fabricated for rectangular ductwork.

b. Fittings: 304 stainless steel, minimum 16 gauge with continuous welded joints with other specifications same as for medium pressure round duct. Minimum 16 gauge for quench duct fittings to match.

c. Butt weld all stainless steel duct joints continuously. Provide Van Stone flanged joints with Hypalon gaskets and silicone mastic where there is no room for welding and/or where shown on Drawings, only where approved in advance by the Owner. There may be no more than 5 percent flanged joints out of all joints, including shop and field welded joints. Swage/socket welded ducts at field joints is not acceptable. All welded systems shall be butt-welded construction. Folded flange welded connections are not acceptable to fume exhaust ducts.

d. Provide a flanged removable spool piece at each fume hood connection, and plenum connection. Spool sections shall be a minimum of 24 inches long and shall be used for leak tests, inspection and to facilitate removal of equipment. Install specified gaskets at flanged joint connections. Provide mock-up of flanged joint connection for Owner inspection. Prove to the satisfaction of the Owner that there is sufficient flexibility to allow for spool removal prior to installation.

e. Slope ducts minimum 10 feet back towards fume hoods, equipment, canopy hoods, drain points, etc. or as shown on the drawings. Low points shall have drain ports.

f. Provide welded-in stainless steel threaded nipples where required for pipe connections such as for canopy hood drains, duct low-point drains, etc.

1) Provide drain from each canopy hood to floor drain or waste receptacle.

F. Chemical Cabinet Exhaust:

1. Where chemical storage cabinets exhaust is 2-1/2 inches or smaller, use 16 gauge 304 stainless steel tubing. Bend all elbows. Minimize joints by bending long sections. Weld sections together.

2. Where chemical storage exhaust is 3 inches and larger, conform to fume exhaust duct requirements above.

G. Flexible Ducts:

1. Diffuser Inlets: Install between the branch supply air duct and the diffuser airtight using the specified clamps. A maximum of seven feet length and two 90 deg turns (or equivalent thereof) will be allowed. Radius of turns shall equal the diameter of the duct. Size shall be equal to the specified diffuser inlet unless otherwise indicated. Support with sheet metal straps from structure to avoid sagging and kinks.
H. Duct Support

1. Attachments to Structure:
   a. See Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment.
   b. Minimum rod or bolt size is 3/8”.
   c. Existing Concrete Structure: Locate expansion bolts or anchors at least six (6) bolt diameters from any edge condition and at least ten (10) bolt diameters from any other anchor. Provide a minimum of six (6) bolt diameters embedment into concrete, unless otherwise noted on the Drawings.
   d. Where point loads imposed by work of Division 23 are greater than allowed value as directed by the structural engineer, provide structural steel spreader beams tied to the building structure. Submit details of all such spreader beams for approval.
   e. See structural drawings for additional restrictions for locating anchors.
   f. Steel Structure: Attach at beam axis. Avoid eccentric loads wherever possible.
   g. Rating: Ultimate strength at least five times the imposed load.
   h. Submit for structural review all support locations, point loads and structural attachment details.
   i. Coordinate installation so that attachments to structure are made prior to fireproofing or new concrete being poured.
   j. If attachments must be made after fireproofing, then thoroughly clean area of fire proofing before welded or bolted attachments are made and replace fireproofing as necessary.
   k. Conform to the requirements of CBC Section 1925 A-1, "Anchorage to Concrete," and Section 1925 A-3-5 "Drilled-in Expansion Bolts."

2. Outdoors
   a. Coordinate with structural and architectural duct and pipe support systems.
   b. Coordinate with architectural for flashing, counter-flashing, and waterproofing requirements at support connections to roof and structure.

3. Indoors:
   a. Suspend horizontal rectangular ductwork 48" or less in largest dimension from construction by 1" x 18 gauge galvanized strap hangers screwed 8" o.c. to ducts. Use three screws minimum per strap. Bend strap under duct and screw into bottom of duct.
b. Suspend horizontal stainless steel 48" or less in largest dimension from construction by 1" x 18 gauge galvanized steel strap hangers bolted to mating flanges at minimum of three locations. (Top, middle, and bottom).

c. Ducts over 48" in largest dimension support from Unistrut, Superstrut, or equal, trapeze hangers sized for the load, per SMACNA standards.

d. Support round and flat oval steel ductwork from construction by 1" x 18 gauge galvanized strap hangers with inside radius of loop hanger equal to outside radius of duct. For ducts under 12" diameter, provide supports 10'-0" o.c.; 12" and over, 6'-0" o.c. Provide not less than one hanger per branch and at each change of direction.

e. Support round flexible ductwork at diffuser inlets using 1-1/2" x 22 gauge galvanized strap hangers with inside radius of loop hanger equal to outside radius of duct. Locate supports to avoid kinks and sharp bends.

f. Double fold straps at attachment to structure.

g. Space Hangers not over 96" on center for ducts smaller than 18" in largest dimension; 60" o.c. for ducts 18" and over.

h. All indoor exposed ductwork in occupied spaces, such as corridor, lounge, conference rooms, offices, shall be supported by hanger rods only and no sheet metal straps shall be used.

3.3 OUTDOOR DUCTS

A. Exposed outdoor ductwork shall be watertight and sloped to avoid water standing on top.
   1. Cover galvanized ducts at the roof with 20 gauge galvanized sheet metal or pitch duct roof min. 1/8" per foot slope.
   2. Pitch to drain.
   3. External covers at least 2 inches beyond edges of protected ducts and plenums.
   4. Overlap and seal covering materials.
   5. Support at duct reinforcement intervals.

B. All steel parts including nuts and bolts for duct supports outdoors or on roof shall be hot-dipped galvanized after fabrication or factory applied.

C. Coordinate with structural and architectural duct and pipe support systems, curbs, pedestals, etc.

D. Coordinate with architectural for flashing, counter-flashing, and waterproofing requirements at support connections to roof and structure.

E. Where ducts pass through the roof or exterior walls:
   1. Coordinate size, locations, and flashing requirements.
2. Provide water-tight counter-flashing between duct to roof curb, flashing, etc.

3.4 DUCT ACCESSORIES

A. Flex Connectors: Install at the inlet and discharge of each fan where shown on the drawings in accordance with the manufacturers directions.

B. Duct Access Doors: Install in ducts and in plenum walls where shown and where required for cleaning and for access to equipment and devices in ducts, including access to duct smoke detectors provided under Division 26. Doors shall be airtight. Provide access doors upstream of reheat coils at variable volume terminals and duct mounted reheat coils.
   1. Access door in plenums shall be as shown on the Drawings.
   2. Install hasp for padlock at each fume exhaust plenum access door. Provide label "Warning - Hazardous atmosphere. Breathing apparatus required."

C. Volume Dampers:
   1. Volume dampers are required on each branch of supply, return, and exhaust ductwork. Install where shown on the Drawings. Where not specifically shown, install damper as far upstream from air outlet/inlet as possible.
   2. Provide remote damper operator, whether noted on the Drawings or not, wherever volume dampers above the ceiling are not readily accessible. Obtain Owner's approval for location prior to installation of any remote damper operator. Securely fasten operators to ceiling or wall construction so that operator box is flush with the finished surface and cover overlaps finished surface.
   3. All dampers shall operate smoothly, without binding, throughout the entire 90 deg range; full open to full closed. Single leaf dampers shall have no more than 5 percent open areas for edge and end clearance when tightly closed. Dampers shall be rigid on operating rods and shall not produce any objectionable vibration, noise, or pressure drop in normal operating positions.

D. Motorized Dampers: Set to open and close smoothly and completely.

E. Fixed Turning Vanes: Not allowed in exhaust ducts. Install specified vanes in square elbows. Vanes shall run full diagonal dimension of elbow with first vane tight in heel corner. When turning vanes are installed in duct with internal insulation, install 20 gauge hat channels of same depth as insulation, and secure vane runners to channels.

F. Tap-In Fitting: Fabricate and install fittings with 45 deg flared inlet for rectangular duct or conical inlet for round duct in accordance with SMACNA "HVAC Duct Construction Standards".

G. Provide stainless steel welded-in threaded nipples where required for exhaust pipe connections such as flammable storage cabinet vents, etc.
3.5 SOUND TRAPS
A. Install in accordance with manufacturer’s directions.
B. Bolt sound traps together as required to form one assembly.
C. Install continuous metallic nosing at air inlet side.
D. Connect to ductwork with joints specified for the duct pressure class.
E. After installation, measure the pressure drop through each soundtrap. If pressure drop exceeds design losses, including accounted-for system effects, replace the soundtraps and/or modify the inlet and/or discharge conditions.

3.6 INTERNAL ACOUSTIC INSULATION
A. Insulate supply and exhaust ducts as noted in the drawing on the inside.
B. Rectangular duct insulation shall be attached to duct with 100 percent coverage adhesive plus Omark 12 gauge Insul-Pin, Duro Dyne, or equal, metal clips, with self-locking steel washers, attached to sheet metal with pin welder gun on no less than 18 inches O.C. each way and 6 inches O.C. along all joints and edges.
C. Round duct insulation shall be attached to duct per manufacturer’s recommendations.
D. Neatly apply specified sealant, to seal all insulation joints, seams, and edges. Ensure full sealant coverage over joints, seams and edges. Installed insulation shall be suitable for 4,000 FPM air velocity. Clip off all pins inside ducts.
E. Install metal nosing over the liner edge on the upstream end.
F. All adhesive and insulation material shall be fire-retardant, and U.L. listed.

3.7 DUCT COIL MODULES
A. Support and restraint per drawings.
B. Comb fins and thoroughly clean.
C. Run condensate drains with p-traps and vents to risers/receptacles.

3.8 AIR OUTLETS AND INLETS
A. Diffusers and Registers: Except where indicted, angular offsets, box connections, and other irregular connections at diffusers and registers are prohibited. Where location of diffusers and registers is governed by work in other Sections, such as integrated ceilings, set diffusers and registers to dimensions taken from Section performing the other work.
   1. Paint sheet metal flat black where visible through inlets and outlets.
B. Support duct elbow directly above each ceiling diffuser, register, and grille to structure with two 1" x 18 gauge sheet metal straps. Fasten diffuser, register, or grille to duct drop with minimum two #10 sheet metal screws on each side. In addition, for lay-in ceiling, support each duct or un-ducted diffuser, register, and grille to structure above with two #12 gauge steel wires or two 1" wide x 18 gauge sheet metal straps fastened to opposite corners.

C. Support each snorkel stub-out rigidly, in both lateral and vertical directions, to allow support of the snorkels provided under Division 11.

3.9 SEALING

A. Where firestopping is not required, seal all duct, pipe, and conduit penetrations through partitions at all floors and through interstitial floor with G.E. silicone sanitary sealant, Dow Corning 8650 Interior Sealant, or equal.

1. Provide 0.125- to 0.25-inch gap to be filled with specified sealant for noise and/or vermin control.

B. Do not seal at fire dampers in any way that violates UL or code installation requirements.

3.10 GALVANIZING REPAIRS

A. Repair galvanizing damaged by welding, scratches, etc., using Z.R.C., no known equal, cold galvanizing compound.

3.11 DUCT SMOKE DETECTORS

A. Install duct smoke detectors provided under Division 26 - Electrical. Coordinate with electrical that the duct detectors have proper probe length and coverage and that the proper air velocity is provided. Provide weather cover for outdoor installation.

3.12 CLEANING

A. Clean all plenums and air ducts so that no dirt or dust is present in any system.

B. Examine air handling systems and clear any obstruction and debris. With dampers wide open and closed, run fan systems and check for air leaks.

C. Patch, repair or replace duct work as required. All ductwork shall be made absolutely air tight. Repair or replace ducts and joints as required to the satisfaction of the Owner.

3.13 TESTING

A. Medium pressure ducts and all stainless steel ducts: Use extreme care in the fabrication and installation of the ductwork and plenums to ensure that it will be airtight. Test ductwork and plenums for leaks in sections as the work progresses before insulating. Fire /Smoke dampers, access panels and appropriate branch ducts shall be in place during the testing. Seal off all open ends and then test by one of the methods given in Section 230590 – Testing for HVAC.
3.14 FLUE FOR WATER HEATERS AND BOILERS

A. The factory shall provide complete design services for a complete system for the specific application.

B. Install in accordance with the Drawings, listing requirements, manufacturer's recommendations, and all applicable codes.

C. Provide for building joint and thermal expansion without damage to system or connected equipment. Include all anchors, guides, bracing, terminations, etc.

D. The sizes shown on Drawings are nominal and are based on the scheduled equipment and indicated arrangement.

E. Submit sizing calculations for approval, and furnish larger sizes as necessary for a functional, trouble-free system.

F. Install all accessories provided by the chimney manufacturer such as the barometric relief damper.

G. Seismic Restraint: Contractor to submit detailed seismic engineering drawings along with seismic calculation per CBC 2016 requirements. Provide all necessary steel, cables, and related roofing/architectural work as required for the seismic restraint system.

END OF SECTION 233000
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fans.

B. Heat Recovery Coils

1.2 RELATED DOCUMENTS

A. Section 019113 – General Commissioning Requirements
B. Section 230500 – Common Work Results for HVAC.
C. Section 230513 – Common Motor and Drive Requirements for HVAC Equipment.
D. Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment.
E. Section 230548 – Vibration Controls for HVAC Piping and Equipment.
F. Section 233000 – HVAC Air Distribution:
G. Section 237300 – Central Station Air Handling Units.
H. Section 237305 – Split Air Conditioning Unit System
I. Section 230590 – Testing for HVAC.
J. Section 230593 – Balancing for HVAC.
K. Section 250000 – Building Automation System

1.3 SUBMITTALS

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. Fans: Dimensional data, materials of construction, weights, certified curves, accessories and options provided.
   2. Inlet and outlet sound power levels, in octave bands of frequency.
   3. Dynamic balance details.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for HVAC.
1. Startup and Service Procedures.
2. Lubrication schedule.

1.5 REGULATIONS

B. AMCA Standard 300: Fan sound power ratings.
C. AFBMA: Bearing life.

1.6 SUBSTITUTION OR PRODUCT NOT LISTED AS DESIGN BASIS

A. Any products submitted as substitution or not listed as the design basis shall meet all mechanical performance, electrical demand, weight, overall dimensions, and acoustical performance. Products named in specifications do not relieve the Contractor’s responsibility to meet the project requirement as specified in the Contract Document.

1.7 FACTORY FAN CAPACITY AND NOISE WITNESS TEST

A. Provide witness test for the fan assembly for acoustical performance. The test shall be conducted in accordance with ANSI S1.12 or AMCA, and shall not exceed the maximum sound power level per project documents. Provide a written report.

B. Provide performance witness test for the fan assembly per AMCA 210. Provide a written report showing the test results and the test method used.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

A. Provide direction of rotation, discharge direction, and arrangement conforming to the layouts shown on the Drawings.

B. Provide AMCA certified rating for performance and sound based on testing in an AMCA accredited laboratory.

C. Provide AMCA Class as specified or scheduled (but not less than Class 2) for continuous operation at 110% of scheduled RPM and 120% of scheduled static pressure.

D. Wheels

1. Wheels shall be steel unless required to be stainless steel or aluminum. See Drawings.

2. Centrifugal fan blades shall be continuously welded to the backplate.

3. Air foil, backward inclined or forward curved, as scheduled. See Drawings.
E. Housings and bases (where applicable)
   1. Inlets: Fully streamlined, with connection flanges or collars.
   2. Outlets: flanged.
   3. Brace to prevent vibration or pulsation. Centrifugal fans are to be braced on the sides of the housings shall consist of structural angle iron extending the complete height of the unit.
   4. Continuously welded throughout. Spot welding is not acceptable.
   5. Fans shall be complete with a structural base supporting the fan and motor.
   6. Weather hoods at outdoor fans and fans greater than 10 inches shall have bolted access doors.
   7. Where fan casings are scheduled to be stainless steel, all components shall be 316 stainless steel, including but not limited to scroll, frame, braces, motor support, scroll drains, and weather hoods. See Drawings.
   8. Where fan casings are scheduled to be coated, all components, inside and outside, are to be coated. See Drawings.

F. Bearings
   1. Air handling quality concentric mount bearings.
   2. Minimum L-10 life of 200,000 hours at maximum speed of fan's AMCA class.
   3. Support on heavy structural supports down to the structural base member of the fan.
   4. Provide shaft seals at fume exhaust fans to prevent escape of fume exhaust air to the surroundings.

G. Vibration Control
   1. See Section 230548 – Vibration Controls for HVAC Piping and Equipment.
      a. See Section 230590 – Testing for HVAC, for factory and field testing requirements.

H. Provide accessories and options as specified below and as shown on the Drawings.
   1. Provide all OSHA approved ventilated guards and screens as required by applicable codes.
   2. Provide access points for shaft and motor RPM readings without disassembly.
   3. Motors and drives shall be completely enclosed and ventilated.
   4. AMCA spark-resistant construction per AMCA 99, Standard 401 where scheduled; see Drawings.
   5. Anti-reverse rotation device for parallel operated fans.
6. Where scroll drains are required, they shall be at the low point in the side panel and shall have a threaded connection.

7. Extended grease lines where bearings are not readily accessible.

8. Stainless steel fans to have all stainless steel hardware.

I. Coordinate and advise VFD manufacturer of critical frequencies on which the unit should not run. Critical frequency filters shall be provided by VFD manufacturer.

2.2 SPECIFIC FAN TYPES

A. Mixed Flow Fan: Greenheck QEI, Twin City, Barry Blower, or approved equal fully welded, mixed flow fan. Fan housings shall be designed to provide straight line air flow from entrance to discharge. Unit shall be complete with Slipfit inlet and outlet collars, totally enclosed belt guard, heavy duty steel motor supports with adjustment screws for belt tensioning. Unit equipped with heavy duty, self-aligning ball or roller face mounted bearings with extended lubrication lines. Fan shall be non-overloading. Fans shall be ceiling hung fans. Fans shall have punched flanged connections at inlet and outlet, motor compatible with VFD, and universal mounting system.

B. Ceiling Mounted Cabinet Fans: Fans shall be direct driven with the drive assembly and motor housed within the cabinet enclosure. The motor shall be equipped with ball bearings. The motor and drive assembly shall be accessible through removable side panels. The enclosure shall be of galvanized steel of not less than 20 gauge. The cabinet fans shall be complete with backdraft damper, support channels, and acoustical lined fan housing. Manufacturer shall be Greenheck SP model, Penn, ACME, or equal.

C. In-line Exhaust Fan: Duct mounted fans shall be of the centrifugal belt driven in-line type. The fan housing shall be heavy gauge galvanized steel construction and shall include square duct mounting collars. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. Motor shall be heavy duty ball bearing type. Motors and drives shall be mounted out of the air stream. Motors shall be readily accessible for maintenance. Fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. A NEMA 1 disconnect switch shall be provided. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance. Fans shall be Greenheck Model BSQ, Penn, AMCA, or equal.

D. Direct Drive High Plume Exhaust Fans:
   1. Plasticaire Skyplume, Strobic or approved equal.
2. Fan, stacks, and plenum shall be of FRP or coated steel construction.

3. Each fan shall be direct driven. Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.

4. Fan impellers shall be mixed flow (axial / backward cured) and shall be manufactured of steel and coated with a minimum of 4-6 mils epoxy. The impellers shall have non-stall and non-overloading performance characteristics with stable operation at any point on the fan curves. Stationary discharge guide vane sections shall be provided to increase fan efficiencies.

5. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence, and manufactured of coated steel with a minimum of 4-6 mils epoxy. No uncoated metal fan parts are allowed. Minimum AMCA C spark-resistant rating.

6. Discharge shall include twin FRP nozzles with passive third central tracks that are capable of generation aspiration. The FRP shall be chemically and UV resistant. The discharge shall include a windband to induce ambient air up to 270% of fan capacity. The nozzle shall be suitable for field installation on a field provided flanged extension discharge duct. Submit discharge volumes for all fans at specified primary exhaust flow and discharge plume height at specified wind velocity.

7. Provide housing drain attached at the lowest point for condensation removal.

8. PTFE gaskets shall be provided at all companion flanged joints.

9. Fans to be equipped with lifting lugs.

10. Fan stand to be coated steel with a minimum of 10-12 mils epoxy.

11. Fasteners shall be 316 stainless steel.

12. Provide a bolted access door for impeller inspection and service on each fan.

13. Electric motors: See Section 23 05 13 Common Motor and Drive Requirements for HVAC Equipment, for requirements.

14. A NEMA 4X junction box shall be provided, factory mounted and wired to the motor from the VFD compartment. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.

15. Coated shaft to be ANSI C-1045 steel. Fan shaft bearings shall be ball or spherical pillow block type, sealed to retain lubricant and exclude dust and air, selected according to bearing manufacturers recommendations, and sized for an L-50 bearing life of 200,000 hours.

16. Provide inlet mixing plenums:
   a. Inlet plenums shall be provided as shown on drawings, custom sized to handle the number and size of duct connections shown on the drawings.
The panels shall be constructed of minimum 18 gauge reinforced steel with Duraplate 154, 10-12 mils DFT epoxy coating both interior and exterior or FRP construction for fume hood exhaust.

b. Provide 1-inch square stainless steel screen in front of all dampers.

c. Low leakage fan inlet isolation dampers shall be fabricated of epoxy coated aluminum airfoil extrusions. Operators shall be 2-position, spring return and shall be 24V electric. Damper linkage shall be externally accessible for manual closure. The electric operator shall be field wired to open when the fan is energized and close via a spring return when de-energized. When fans ship separate from the plenum, all wiring and conduit shall be factory supplied for connection in the field. Coordinate requirements with the Building Automation System. Provide a stainless steel sound trap at each outside air bypass damper. See drawings for details.

d. Provide a stainless steel 3 feet long sound attenuator at the mixing dampers for noise treatment. The sound attenuator shall be selected specially to reduce the noise generated by the bypass damper. Submit performance data for the Engineer’s review. The Sound attenuator shall be supported by the mixing plenum as an integrated unit. Any field work required shall be furnished by the fan manufacturer.

17. Provide 14 gauge galvanized steel roof curbs to support the plenums. The curb shall be minimum 14 gauge. There shall be hold-down points for connection to the structure. Provide additional structural frame as required.

18. Provide discharge nozzle silencer.

2.3 MOTORS AND DRIVES
A. See Section 230513 – Common Motor and Drive Requirements for HVAC Equipment. Provide TEFC specified efficiency motors.

2.4 FAN SUPPORT AND VIBRATION ISOLATION
A. See Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment.
B. See Section 230548 – Vibration Controls for HVAC Piping and Equipment.
C. Provide unit-mounted disconnect switch and motor protection to individual fan motor for system with multiple fans.

PART 3 - EXECUTION

3.1 FANS:
A. Install flexible duct connections at every duct connection, except for all the high plume exhaust fans.
B. Support and isolate per Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment and 230548 – Vibration Controls for HVAC Piping and Equipment, and as shown on Drawings.

C. Repair all nicks in finish.

D. Pipe all fan scroll drains to designated waste systems.
   1. Provide polypropylene pipe and shut-off ball valves in fume exhaust fan drains.

E. Testing: Section 230590 – Testing for HVAC.

3.2 BEARINGS

A. Be responsible for the protection and proper lubrication of the bearings before operation of equipment. Give special attention to bearings in any equipment that has been delivered to the job site, or installed, in advance of completion.

B. All bearing lubrication points shall be both visible and safely accessible after installation of equipment. Fit with proper lubrication fittings, and fill each pipe with proper lubricant.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air Handlers
   1. Outdoor units
   2. Indoor units

1.2 RELATED DOCUMENTS

A. Section 019113 – General Commissioning Requirements
B. Section 230500 – Common Work Results for Mechanical.
C. Section 230513 – Common Motor and Drive Requirements for HVAC Equipment.
D. Section 230529 – Hangers, Supports, and Seismic Restraints for HVAC Equipment.
E. Section 230548 – Vibration Controls for HVAC Piping and Equipment.
F. Section 233400 – HVAC Fans.
G. Section 233000 – HVAC Air Distribution.
H. Section 230590 – Testing for HVAC
I. Section 230593 – Balancing for HVAC.
J. Section 232900 – Variable Frequency Drives.
K. Section 250000 – Building Automation System.

1.3 SUBMITTALS

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. Air Handlers: Construction, features, dimensions, shipping sections, field joints, weight, certified performance, sound power levels at cabinet inlet and outlet and cabinet radiation, anticipated factory test dates, and factory test result reports.
      a. Provide plans and elevations at minimum ¼” scale.
   2. Fan curve for individual fan in each array system and combined fan array curves.
   3. Pre-filters.
   4. Final Filter.
5. Variable frequency drive.
6. Air flow meter and transmitters.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit in accordance with Division 1 and Section 23 05 00 – Common Work results for Mechanical.
   1. A detailed description of the operating system, its components, and principals of operation.
   2. Startup and service procedures and checklists.
   3. Relevant data such as bill of materials, parts list, drawings, etc. Where necessary, manuals shall include exploded diagrams of relevant equipment to provide sufficient detail and clarity with which to identify replacement parts.
   4. Assembly and disassembly instructions for parts replacement or servicing requirements.
   5. Recommended spare parts list with current prices, including sizes of fan belts and filters.
   6. Preventative maintenance and lubrication schedules.
   7. Troubleshooting procedures.
   8. List of telephone numbers of local service organizations.
   10. Final copy of factory test reports.

1.5 FACTORY WITNESS LEAKAGE, PERFORMANCE AND ACOUSTICAL TESTS FOR EACH UNIT

A. Leakage Test: Pressure test the entire air handling unit at 1.5 times the scheduled fan total static pressure. The maximum leakage shall be less than 0.8% of the maximum designed flow rate. Repair leakage and retest unit until it passes. Provide a written report showing the test results and the test method used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

   A. Alliance, Energylab, Temtrol, Haakon, or approved equal.

2.2 FABRICATION

   A. Side and roof panel construction.
1. Panels shall utilize standing seam construction or welded frame on interior and are to be welded construction or double-turned inward flange with mechanical bolts and nuts. Casing shall be of not less than 16 gauge galvanized construction with all joints sealed and/or gasketed against air leakage at maximum rated pressure of the unit. Roof shall be constructed of multiple panel sections. Roof panels shall have a raised standing seam(s) that are fastened and sealed. The casing construction shall be weatherproof.

2. All walls shall be constructed of minimum 2 in (50mm) thick acoustical/thermal panels. Casing shall be built to exceed AMCA Class “C” requirements.

3. Interior liner shall be fabricated from minimum of 22 gauge galvanized steel solid liner, unless specified herein otherwise. Entire interior casing for 100% outside air unit AHU-2 shall be 18GA stainless steel 304 liner for 100% outside air application. Provide 18GA stainless steel 304 interior liner from outside air intake/ economizer section up to fan section for other AHUs.

4. Removable type lugs: string lug assembly shall be welded to the header of the units. Rigging and lifting safety instructions shall be attached to unit.

B. Base, unit floor, and roof curb construction:

1. Unit base shall be constructed of welded structural steel around the perimeter of unit, with intermediate channel and angle iron supports. Unit shall have a minimum one-piece full length 6-in. channel for each side of the unit. See drawings for further details.

2. The unit floor is to be covered with not less than 3/16-inch aluminum diamond tread plates attached to base channel.

3. Floor shall be insulated with minimum 2” thick insulation.

C. Access doors:

1. Provide full height 2” thick, double wall, insulated, thermal-break type, access doors to all fan, filter, and access sections. Exterior door skin shall be constructed from minimum of 16 gauge galvanized and painted steel. Interior shall be painted 20-18 gauge galvanized steel, except otherwise noted in schedule or in this document. Door insulation shall be two inch 3 lb/cu ft density. Door frames are to be one piece, heavy gauge aluminum extrusion with high performance knife edge and closed cell, replaceable neoprene gasket seal. Access doors are to have aluminum extrusion perimeter frame with high performance knife edge and closed cell, replaceable neoprene gasket seal as well. Therefore, door assembly shall have double knife edge/perimeter gasket system (one system on frame and one system on door). Provide a minimum of 12” x 12” viewing window with thermal pane at fan section.

2. Door hinges and latches shall be easily adjustable to allow for a tighter seal between the door and the unit. Door hinges are to be bolted to the unit and made with stainless steel. Hinge shall have stainless steel removable pin to allow door to be easily removed during servicing. Door latch and paw assembly
shall be industrial quality and corrosion resistant with a handle on both the inside and outside of door. Latch and paw assembly shall be one piece and bolted together.

3. All access doors shall open against unit operating pressure. Provide “pressure breaker” door for doors which are designed to swing outward from pressurized sections.

D. Insulation:

1. The wall and ceiling panels shall be insulated with 2” - 3 lb./cu. ft. duct board insulation secured in place unless otherwise noted.

E. Painting:

1. All panels (wall and ceiling) shall be coated with a 2 to 3 mil coat of carbon backed acrylic enamel over an epoxy primer. All panels are primed and top coated on both sides. Paint color shall be approved by Architect.

2. Entire structural steel base shall be painted with alkyd enamel. Industrial grade alkyd enamel red oxide primer shall be applied by air brush to 2 mils thickness and alkyd enamel top coat shall be applied by air brush to 2-3 mils thickness, for a total dry thickness of 4-5 mils.

F. Plug Fan Assembly:

1. Fan performance shall be per AMCA Standard 210. All fan performance shall be available in manufacturer's published catalogs. Fan shall be sized to perform as scheduled in the contract documents. The wheel diameter shall not be less than that scheduled in the contract document and shall be constructed to AMCA Class Standards as applicable for the scheduled duty. Provide plenum fan wheel enclosures and belt guards.

2. Fan and motor shall be mounted on a fully welded, rigid steel base. Unpainted or galvanized, bolted-together or non-welded steel bases are not acceptable. Base shall be free-floating at all four corners on spring type isolators. The structure supporting the bearing pedestal shall be fabricated from welded formed steel and welded to fan base. The fan assembly shall be isolated by painted, color coded, steel springs. The springs shall be free-standing, un-housed, stable steel springs, with leveling bolts and neoprene isolation pad, selected to a minimum efficiency of 98% to 99% depending on the fan RPM. Vibration isolation base shall have earthquake restraints capable of containing the fan in all directions with up to 1/2 g of force applied. A thrust restraint shall be provided when the thrust of the fan during operation and start up may cause the fan assembly to ground against the floor, walls, seismic restraints, or when required to keep the flexible connection from becoming taut. Adjust the spring isolators and seismic snubbers at the completion of the field assembly.

3. The fans shall be centrifugal direct drive airfoil blade, plug type and shall be designed to operate at cataloged performance without an involutes housing. The wheels shall be fabricated from heavy gauge extruded aluminum air foil blades.
4. Fan bearings shall be ball or roller type. Sleeve bearings are not acceptable. Bearings shall have replaceable bearing inserts so the entire housing need not be replaced. The bearing shall be self-aligning to assist in the shaft alignment. Self-locking collars shall be provided to secure the bearing to the shaft. The bearing housing shall be cast-iron. All grease fittings shall be extended to the accessible side of the fan framing for ease of re-lubrication. The lubrication lines shall be clear nylon material to facilitate visual confirmation of grease in the line. Bearings shall have a minimum L-10 life hour of 200,000 on all fans.

5. Motors shall be premium efficiency type. RPM as scheduled on drawings; see motor specification for minimum efficiency.

6. Provide adequate length for fan plenum prior to the inlet of the fan to ensure fan performance.

7. Provide a holding frame for a factory furnished blank-off plate at the suction of each fan for maintenance isolation.

8. Provide shaft grounding ring for VFD operation.

G. Coils:
1. Install coils such that headers and return bends are enclosed by unit casings.

2. Construct coils of configuration plate fins and seamless tubes. Fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

3. Construct coil casings of minimum 16 gauge type 304 stainless steel with formed end supports and top and bottom channels.

4. Heating Hot Water Heating Coils
   a. Clearly label supply and return headers on outside of units such that direction of coil water-flow is counter to direction of unit air-flow.
   b. Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.
   c. Construct headers of non-ferrous, seamless copper.
   d. Construct tubes of 5/8 inch O.D. minimum 0.020 inch thick copper and construct 0.01" fins of aluminum.
   e. Entire coil shall be coated with Adsil Microguard coating, no substitution.

5. Chilled Water Cooling Coils
   a. Chilled water coils shall be of the plate fin extended surface type and ARI 410 certified for water. The primary surface shall be a minimum of 5/8” outside diameter seamless copper 0.020” minimum wall thickness, and shall be expanded into the fin collars to provide a permanent mechanical bond: no metallic or thermal bonded materials shall be used. The secondary surface shall be flat or formed of 0.01” aluminum fins. All coils shall be constructed with .025” thick brazed replaceable return bends.
Same end connections are required. Headers shall be non-ferrous seamless copper, and provided with tobin bronze brazed copper male pipe connections and separate 3/8" diameter pipe vent and drain connections extended through unit casing. All coils shall be fully drainable with no trapped tubes by design. All coils shall be counterflow construction, with connections left or right hand as specified on the drawings. The use of internal restrictive devices “Turb” to obtain turbulent flow will not be accepted. Spiral fin coils are not acceptable on any dehumidification coils unless face velocity is kept under 350 FPM. All copper to copper joints shall be made with high temperature brazing material: no pressure bonding or roller expanded bonding shall be used. Entire coil shall be coated with Adsil Microguard coating, no substitution.

b. Coil casings shall be minimum 16 gauge, Type 304 stainless steel with double formed 3/4" flange on all sides of coil with tube sheets having extruded tube holes. Coil casing Reinforcements shall be furnished so that the unsupported casing length is not over 60”. Reinforcements shall be made of same material as coil casing.

c. All tubes shall be tested at a minimum of 1500 PSIG and all assembles tested under water at 350 psig and rated for 180 psig working pressure. Provide plates at both ends of the coils to divert the condensate drip from the headers and return bends into the drain pan.

d. The coils shall be arranged for easy removal by means of 16 gauge stainless steel rail rack on which the coil is mounted. The end of the coils shall be carefully blanked off with 16 gauge stainless steel to insure all of the air passes through the coils. Intermediate condensate pans are to be furnished on stacked coil units to prevent upper coil condensate from passing over the lower coil. Intermediate drain pans are to be fabricated from the same material as the primary drain pan. Stainless steel intermediate drain pans shall have 1” copper down spouts. The water headers shall be located inside the cabinet casing with only the connecting pipe stubs extended through the cabinet.

H. Double Sloped Condensate Drain Pans:

1. Provide a stainless steel condensate drain pan for the chilled water coils of deep, double sloping design which slopes in 2 directions, downstream from cooling coil and also toward the outlet side. The drain pan shall slope 1/8” per foot toward drain connection and be placed under the entire coil section and extend in the direction of air flow a minimum of 6” beyond the leaving edge of the coil. Entire drain pan shall be easily accessible for annual inspection and cleaning.

2. The pan shall be of welded 304 Stainless Steel construction. Provide double wall pan.

3. The unit shall have a single 1-1/4” M.P.T. drain connection on same side of unit as coil connections. The drain connection shall be fabricated with same material as main drain pan and connection shall be installed below the bottom of the drain pan.
4. Provide an additional drain pan with the same spec at the outside air intake section with grating on top.

I. Filter Sections:

1. High Efficiency Filter: Farr RIGA-FLO 15, Envo, American Air Filter, or approved equal, 12” deep, MERV 15/95% efficiency per ASHRAE Test Standard 52-76, U.L. Class2, rigid type. Filter shall consist of high density media, media support grid, contour stabilizers, diagonal support bracing. Filter media shall be of high density microfine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. Pre-filter section shall be minimum MERV 8/30%, 2” thick disposable filter.

2. Construction Filters: 2” thick disposable blanket media filters for use upstream of rigid filters during construction.
   a. The framing members shall be permanently gasketed. System shall be suitable for upstream service of all filters.
   b. Air Filter Gauges: F.E. Dwyer Magnehelic Model 2001, no known equal, with 0-1” scale for low efficiency filters and 0-2” scale for high efficiency filters, 4” diameter, static tips, mounting frame. Provide copper tube connections and specified gauge cocks on upstream and downstream side of each filter bank. Clip minimum 1/8” copper tubing every 18”.
   c. Provide access door each side of units as indicated in the contract documents. Filter racks shall be 304 stainless steel construction.

J. Outside Air Plenum Section

1. Outside air plenum section shall be equipped with an outside air intake louver and motorized damper, except 24/7 – 365 unit(s). The inlet of the louver shall have a 1/2” stainless steel wire mesh. All interior liners for 100% outside air unit shall be 18 ga., 316 stainless steel.

K. Electrical Requirements:

1. Provide junction box(es) for field power connection. The electrical construction shall be according to N.E.C. regulations and contain a U.L. 508 label.

2. The electrical contractor shall bring separate power each power connection as indicated on drawings. Provide individual power connection to each supply and return fan array system for each air handling unit.

3. Provide 1 marine light in each section as detailed in unit drawing, wired to a single weatherproof switch located on flush mounted, power panel. Control panel shall have separate circuit breaker for lights. All internal wiring to lights shall be in conduit and internal to unit. No external conduit runs or wall penetrations are allowed.

4. All sensors located inside of unit shall be furnished by the Contractor for factory mounting by unit manufacturer. Provide all necessary wiring and conduit inside of unit and terminal strip at unit wall for control Contractor’s connection. Refer to
Division 26 for wiring/conduit and other electrical/control requirements. No exposed controls wiring, including plenum rated cables, shall be installed inside the air handling unit. All wiring must be installed in conduits. Seal conduit penetrations air-tight.

5. Provide ventilated compartment for housing VFDs and control panels. Cooling shall be achieved by the air flow stream in conjunction with factory designed heat sink or integral air conditioning, if required.

6. Provide factory power distribution and individual motor protection circuit per code requirement. The factory power distribution system shall include a single main breaker and sub-breakers for fan disconnection and motor protection.

L. Sound Power Levels

1. The operating sound power level at the air handling units discharge, fresh air inlet and/or casing radiated shall not exceed the values submitted by the manufacturer and indicated on contract documents.

2. Air handling units sound power level data shall be submitted to the Architect/Engineer for approval. The submitted data shall be based on sound power measurements on similar units.

3. All sound power level measurements and calculations shall be in complete accordance with the latest (at time of bid) version of AMCA standard 300, Test Code for Sound Rating, AMCA standard 301, Method for Calculating Fan Sound Ratings from Laboratory Test Data.

M. Air Flow Measurement:

1. Fan Inlet: Provide airflow measurement at inlet of each plenum fans at each air handling unit. The system shall include the provision of measuring differential pressure across the fan inlet cone and associated pressure transmitter. Product shall be similar to Twin City’s Piezometer Ring or Greenheck sure-Aire. The system shall complete with a transmitter to provide CFM output and a local LED display. The transmitter shall be capable of summing two individual fan inputs and provide a total air flow signal to the BAS system. Provide additional transmitters and air flow measurement to accommodate the total number of fans for each array.

2. Outside Air Intake: Unit shall be VOLU-flow / OAM Expanded (16:1 range) outside air monitor, or approved equal. The air flow measurement system shall include an outside reference sensor, inlet air flow sensor, NEMA 4 controller with, and dual inlet. The monitor/controller shall contain an integral multi-line liquid crystal display for use during the configuration and calibration processes, and to display two measured processes (volume, velocity, temperature) during normal operation. All configuration, output scaling, calibration, and controller tuning will be performed digitally in the on-board microprocessor via input pushbuttons. The monitor/controller shall measure inlet airflow with an accuracy of ±5% of reading over a range of 150-600 FPM, 250-1,000 FPM, 500-2,000 FPM, and 150-2,000 FPM and not have its reading affected by the presence of directional or gusting.
wind. **Measured** airflow shall be density corrected for ambient temperature variances, and atmospheric pressure due to site altitude.

N. Factory-Mounted Variable Frequency Drive VFD(s) shall be factory mounted in a ventilated compartment. See Section 232900 for specifications. All power wiring shall be factory mounted for single unit or field installed for field assembled units. VFD shall equip with heat sink as powered exhaust fan to prevent overheating. VFD shall be ABB Microdrive.

O. Control Dampers:
   1. Ruskin CD-60, Air Balance, Inc., or equal. Units shall be steel construction with 16 GA x 5” frame, opposed 16 GA x 6” airfoil blades, concealed damper linkage, vinyl damper seals, bearings and bearing seals, and end switches to monitor full open and full closed positions. Pressure loss shall not exceed 0.12” w.g. when passing air at 2000 FPM velocity. Air leakage shall be less than 4.2 cfm/sf when shut off against 4” w.g. pressure differential. Each section of a damper bank shall be no larger than 60” x 40” maximum. All linkages shall be ganged together except as noted. Provide one damper motor for approximately each 16-square foot section of damper and one for the minimum outside air section (if applicable), each operating on a separate shaft. Size actuators to provide maximum torque acceptable to the damper.
      a. Size dampers sections and provide damper bank reinforcing for larger damper sections for operation up to 7” w.g. differential pressure.

PART 3 - EXECUTION

3.1 AIR HANDLERS

A. General
   1. Coordinate ventilated vestibule space requirements and conduit/wiring requirements with Section 232900 - Variable Frequency Drives.
   2. Coordinate pad requirements.
   3. Set in place using manufacturer’s recommended rigging attachments. Attach air handler to pad as detailed on the drawings.
   4. Install and join air handler sections in the field. All joints shall be sealed airtight.
      a. Adjust doors, dampers, etc.
      b. Connect all internal wiring between sections.
   5. Repair nicks in finish.
   6. Provide training on the operation and maintenance of the air handlers and components.

B. Coils
1. Comb fins and thoroughly clean.
2. Run condensate drains with p-traps and vents to receptacles.

C. Dampers
1. Coordinate actuator mounting requirements with the Environmental Control System contractor.

D. Vibration Control
1. See Section 233400 –Fans.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable Refrigerant Volume (VRV) Systems consisting of high-efficiency split-system indoor multiple fan-coil evaporators, outdoor air conditioning units, refrigerant piping, accessories, and controls.

B. Split system AC units.

1.2 RELATED DOCUMENTS

A. Section 230500 - Common Work Results for Mechanical

B. Section 230529 - Hangers, Supports, and Seismic Restraints for HVAC Equipment

C. Section 230548 - Vibration Controls for HVAC Piping and Equipment

D. Section 230590 - Testing for HVAC

E. Section 230593 - Balancing for HVAC

F. Section 230700 - Insulation

G. Section 233000 - HVAC Air Distribution

H. Section 250000 - Building Automation System

I. Division 26 - Electrical

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

1. Product data. In lieu of hard copy, electronic documents in searchable PDF format are acceptable. Scanned version is not acceptable.

   a. Indoor air conditioning fan-coils and cassettes and outdoor air-cooled condensing units. Including dimensions, features, wiring and piping diagrams, and certified performance.

   b. Refrigerant piping, valves, and trim.

   c. Sound data for all indoor and outdoor AC units.

   d. Factory condensate pump and accessories.

2. Pre-start up and start up checkout form/installation form (including procedures) for the commissioning agent review.
1.4 OPERATION AND MAINTENANCE DATA

A. Submit for all systems furnished under this Section.

B. In addition to the hard copy, include three electronic copies in searchable PDF.

C. Submit as part.

1.5 REGULATIONS

A. ARI certified.

B. U.L. or E.T.L. listed.

C. California Energy Commission Certification: Minimum Efficiency.

D. California Basic Electrical Regulations: Electrical Panel.

1.6 WARRANTY

A. See Division 1.

B. Extended Warranty:
   1. Provide 6 years extended warranty for the compressor.

1.7 TRAINING

A. See Division 1.

PART 2 - PRODUCTS

2.1 GENERAL

A. Daikin, Mitsubishi, LG, or equal. If a manufacturer other than the base design system is submitted then the Contractor is responsible to provide all work, including design, electrical, mechanical, plumbing, structural, and architectural, required to accommodate the necessary changes for the delivery of a complete functional system. All changes will need to be presented in a revised construction document for Engineer’s review and approval.

2.2 COOLING ONLY SYSTEM, VARIABLE REFRIGERANT VOLUME, AIR COOLED

A. The outdoor unit shall contain sufficient refrigerant R-410A to charge the system, a scroll compressor, external brass service valves, charging ports, capillary tube meter device, and low ambient control. Units shall be constructed of galvanized steel with corrosion inhibiting, polyester, powder coated paint 2000 hours salt spray.
B. The indoor units shall be wall mounted and ceiling hung cassette blower coil unit with insulated casing. The fans of the ceiling-mounted units are backward curved centrifugal design, dynamically and statically balanced. Motors shall have thermal protection. Provide permanent, washable filter for ceiling cassette type as and replaceable filters for above ceiling fan coil units.

C. Unit shall be controlled by a field installed DDC thermostat furnished by the VRV system manufacturer.

D. Condenser and evaporator coils shall be constructed of copper tubes with aluminum fins.

E. The unit shall be ARI certified and ETL listed. Performance shall comply with California Energy standards.

F. Unit shall be completely factory wired and tested. Wiring shall comply with California electrical code.

G. Unit performance and characteristics shall be as scheduled on the drawings.

H. Unit shall have single point power connection.

I. The indoor and outdoor units shall provide provisions for the installation of factory smart digital controllers.

J. Controls
   1. Physical characteristics
      a. General: The VRV Controls Network shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.
      b. The Open Protocol Interface shall be made from stainless steel. Each interface shall have a battery backup and LED lights to display status/error.
   2. Electrical characteristics
      a. General: The Open Protocol Interface will require 24 VAC to power the unit. The Open Protocol Interface shall supply 16 volts DC to the communication bus on the F1F2 (out-out) terminal of the outdoor unit. The voltage may rise or fall in relation to the transmission packets that are sent and received.
      b. Wiring: The Open Protocol Interface communication wiring shall be terminated in a daisy chain design at the outdoor unit, then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control

Ratcliff Project 35003.01 DSA Approved March 21, 2018
Addendum 2 – April 26, 2018
3. **VRV Controls Network:**
   a. VRV Controls Network is made up of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol network devices that transmit information via the communication bus. The VRV Controls Network shall also have the ability to be accessed via a networked PC. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, tenant billing, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet® or Lonworks® interfaces; all of which blend to provide the optimal control strategy for the best HVAC comfort solution.

4. **Open Protocol Interfaces:** The Open Protocol Interfaces are designed as a translator between the DIII-Net communications and the protocols used in BACnet and Lonworks integration. The Daikin VRV Open Protocol Interfaces are compatible with all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. The Open Protocol Gateways wiring consist of a stranded non-polar two-wire connection to the outdoor unit. The Open Protocol Interfaces may be wall-mounted and can be used in conjunction with a Building Management System (BMS) to maintain the optimal operation of a minimum of 64 connected indoor unit groups and 128 indoor units (dependent upon interface option configuration). In cases where a system or unit error may occur, the VRV controllers and the BMS central monitoring system will display an error code as specified by Daikin.

5. **DMS502B71: Interface for use in BACnet**
   a. The Interface for use in BACnet shall provide the ability for a Building Management System (BMS) to control all VRV indoor units with the use of the KRP928BB2S RA Adapter.
   
   b. The interface wiring shall consist of a non-polar two-wire connection to the terminals F1F2 (out-out) of the outdoor unit. The Interface for use in BACnet is wall mounted and is used as a translator between the BACnet Building Management System (BMS) and the VRV DIII-Net communication bus to maintain the optimal operation of the connected indoor unit(s).
   
   c. The Interface for use in BACnet shall be capable of supporting Change of Value (COV) notification for all available objects.
   
   d. Mounting: The Interface for use in BACnet shall be mounted on the wall or in an enclosure.
   
   e. Display Features:
1) The Interface for use in BACnet shall be approximately 10.81” x 10.34” in size.

2) LED display provides the interface’s operational status and alarm.

3) The Interface for use in BACnet shall be capable of displaying indoor unit objects on the BACnet building management system.

4) The Interface for use in BACnet shall provide the BACnet building management system the capability to command the setpoint temperature in 1°F (0.1°C) increments with a range of 60°F - 90°F (16°C - 32°C).

5) Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius

6) The Interface for use in BACnet shall provide the BACnet building management system the capability to display the room temperature in 0.1°F (0.1°C) increments with a range of -120°F - 180°F (-84°C - 82°C).

7) Display of room temperature information shall be configurable for Fahrenheit or Celsius

8) Error codes generated by the indoor units, outdoor units, branch selector boxes, and remote controllers shall be displayed on the BACnet building management system in the event of system abnormality/error with a two digit error code as specified by Daikin.

9) Communication errors between the Interface for use in BACnet and the BACnet building management system shall be displayed with a red flashing LED on the Interface for use in BACnet

6. Basic Operation:

a. The Interface for use in BACnet will provide up to 28 objects that can be monitored/controlled via the BACnet building management system (see the Interface for use in BACnet Design Guide –EDUS72-749B)

b. Capable of controlling up to 64 indoor unit groups (128 indoor units) per DIII-Net port (2 DIII-Net ports standard).

c. Optional DIII Board (DAM411B51) can be added to increase DIII-Net ports to a total of 4 DIII-Net ports.

1) This provides a total of 256 indoor unit groups (512 indoor units) that can be monitored and controlled via the BACnet building management system

d. The Building Management System shall control the following group operations:

1) On/Off
2) Operation Mode (Cool, Heat, Fan, Auto, and Dry)

3) Single setpoint setting for Cooling and Heating in the occupied mode.

4) Fan status

5) Fan Speed: Up to 3 speeds (dependent upon indoor unit type)

6) Vane direction (dependent upon indoor unit type): 5 fixed positions or swing position

7) Remote controller permit/prohibit of On/Off, Mode, and Setpoint

8) Filter sign reset for indoor units

9) Disable the Intelligent Touch Controller

10) Forced off of indoor units

11) Forced Thermo-off of indoor units

12) Energy saving offset of indoor unit setpoint

13) Compressor status

14) Thermo-on status

15) Heater status

e. Capable of providing battery backup power for up to 3 years in total time for the clock.

1) Settings stored in non-volatile memory

7. Programmability:

a. The BACnet building management system shall support weekly schedule settings through its programming.

1) The schedule shall support the indoor unit:

2) On/Off

3) Each scheduled event shall specify time and target group

4) Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) setback setpoint, Setback (Heating) setback setpoint, Remote Controller On/Off Permit/Prohibit, Remote Controller Mode Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable

5) Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied) by Group
6) An override shall be provided for use enabling indoor unit operation during the unoccupied period by the BACnet building management system programming.

b. The BACnet building management system shall support auto-changeover through its programming.

1) Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat in accordance with the room temperature and setpoint temperature.

2) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained on the same DIII-Net communication bus to the same outdoor unit in the Heat Pump system or the same branch selector box in the Heat Recovery system.

3) Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint.

4) Differential to be determined by BACnet building management system programming.

5) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint.

6) Differential to be determined by BACnet building management system programming.

7) Guard timer

8) Upon changeover, guard timer will prevent another changeover during this period.

9) Guard timer should be ignored by a change of setpoint manually from the BMS, Intelligent Touch Controller, Remote Controller, or by schedule.

10) Guard timer to be configured by BACnet building management system programming (30 minute minimum recommended)

c. The Interface for use in BACnet shall support force shutdown of associated indoor unit groups.

K. Outdoor and Indoor air conditioning units

1. The variable capacity air conditioning systems shall be a Daikin Variable Refrigerant Volume Series (heat and cool model) split system, or equal. The system shall consist of multiple evaporators, “Y” joints and headers, a two-pipe
refrigeration distribution system using PID control, and VRV outdoor units. The outdoor unit is a direct expansion (DX), air-cooled air conditioning, multi-zone air-conditioning system with variable speed driven compressors using R-410A refrigerant. The outdoor units may connect an indoor evaporator capacity up to 200% of the outdoor condensing unit capacity. All zones are each capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance.

2. The outdoor units shall be interconnected to indoor units utilizing the manufacturer’s “Y” piping joints and headers to ensure correct refrigerant flow and balancing. The system shall be capable of refrigerant piping up to 540 actual feet or 623 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps. “Y” piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

3. Operation of the system shall permit either individual cooling of each indoor unit. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BAS interface.

4. Warranty
   a. Warranty the compressor and all parts for a duration to ten (10) years starting from the “installation date” which is one of the two dates below:
      1) The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit’s rating plate.
      2) If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

5. Cooling Only Outdoor Units
   a. General: The condensing unit is designed to work with the selected indoor units.
      1) The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.
      2) The condensing unit can be wired and piped with access from the left, right, rear or bottom.
3) The connection ratio of indoor units to condensing unit shall be permitted up to 200%.

4) Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.

5) The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.

6) The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

7) The unit shall incorporate an auto-charging feature. Manual changing should be support with a minimum of 2 hours of system operation data to ensure correct operation.

8) The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

9) The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

10) To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

11) Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation.

12) The condensing unit shall be capable of cooling operation at dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

b. Unit Cabinet: The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

c. Fan:

1) The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2) The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.

3) The fan shall be a vertical discharge configuration.

4) The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

5) The fan motor shall be provided with a fan guard to prevent contact with moving parts.

6) Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

6. Condenser Coil:
   a. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
   c. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
   d. The fins are to be covered with an anti-corrosion Ultra Gold coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test: 500hr (ASTM G85 & Blister Rating:10)
   e. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

7. Compressor:
   a. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
b. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll type.

c. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

d. The capacity control range shall be as low as 3% to 100%.

e. The compressors’ motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.

f. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

g. Oil separators shall be standard with the equipment together with an intelligent oil management system.

h. The compressor shall be spring mounted to avoid the transmission of vibration eliminating the standard need for spring insolation.

i. In the event of compressor failure the remaining compressors shall continue to operate and provide cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

8. Electrical:

a. The power supply to the condensing unit shall be 460 volts, 3 phase, 60 hertz +/- 10%.

b. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.

c. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

d. The control wiring lengths shall be as shown below.

<table>
<thead>
<tr>
<th>Control Wiring Length</th>
<th>Condenser to Indoor Unit</th>
<th>Condenser to Central Controller</th>
<th>Indoor Unit to Remote Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor Type</td>
<td>16/18 AWG, 2 wire, non-polarity, non-shielded, stranded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>6,665 ft</td>
<td>3,330 ft</td>
<td>1,665 ft</td>
</tr>
</tbody>
</table>
L. If an alternate manufacturer is selected, the mechanical contractor shall provide, at their own cost and expense, any additional material and labor to meet the published sound levels above.

1. Refrigerant Valves:
   a. The unit shall be furnished with 3 electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
   b. The refrigerant connections must be of the braze type.
   c. In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundancy must be provided.
   d. Multiple indoor units may be connected to a branch selector box with the use of a REFNET™ joint provided they are within the capacity range of the branch selector.

2. Condensate Removal:
   a. The unit shall not require provisions for condensate removal. A safety device or secondary drain pan shall be installed by the mechanical contractor to comply with the applicable mechanical code, if an alternate manufacturer is selected.

3. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
   b. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
   c. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.
   d. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

M. Indoor Units: 4-Way Ceiling Cassettes, 2’x2’

1. General: The indoor ceiling cassette unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Performance: Each unit’s performance is based on nominal operating conditions:

3. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
4. Both refrigerant lines shall be insulated from the outdoor unit.

5. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.

6. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.

7. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21” of lift and has a built in safety shutoff and alarm.

8. The indoor units shall be equipped with a return air thermistor.

9. All electrical components are reached through the decoration panel, which reduces the required side service access.

10. The voltage range will be 253 volts maximum and 187 volts minimum.

11. Unit Cabinet:
   a. The cabinet shall be space saving and shall be located into the ceiling.
   b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
   c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
   d. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
   e. A branch duct knockout shall exist for branch ducting supply air.
   f. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

12. Fan:
   a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
   c. The airflow rate shall be available in high and low settings.
   d. The fan motor shall be thermally protected.

13. Filter:
   a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

14. Coil:
a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
c. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
d. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
e. A condensate pan shall be located under the coil.
f. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
g. A thermistor will be located on the liquid and gas line.

15. Electrical:
   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

16. Control:
   a. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
   b. The unit shall be compatible with interfacing with a BMS system via BACnet gateway.

17. Optional Accessories:
   a. Remote “in-room” sensor kit (KRCS01-1B).
      1) Replaceable without tools.

N. Wall Mounted Unit

   1. General: The indoor wall-mounted unit shall be operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space, with finished white casing.
   2. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. A mildew-proof, polystyrene air filter and condensate drain pan shall be included as standard equipment. The indoor units sound pressure
shall range from 32 dB(A) to 35 dB(A) at low speed measured at 3.3 feet below and from the unit.

3. Indoor Unit
   a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the nit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe shall be capable of being fitted to from either left or right sides.
   b. Indoor unit and refrigerant pipes shall be charted with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulate from the outdoor unit.
   d. Return air shall be through a resin net mold resistant filter.
   e. The indoor units shall be equipped with a condensate pan.
   f. The indoor units shall be equipped with a return air thermistor.

4. Unit Cabinet
   a. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
   b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

5. Fan
   a. The fan shall be a direct-dive, cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.

6. Factory furnished condensate transfer pump
   a. In-line pump wired to indoor unit with integral controls.

2.3 REFRIGERANT PIPING

A. Above Ground: Refrigerant piping shall be Type L, ARC, Hard drawn, deoxidized and dehydrated copper tubing and forged sweat type copper fittings. Solder shall be silver. Provide field applied insulation per Specification Section 230700.
PART 3 - EXECUTION

3.1 AIR CONDITIONING SYSTEMS, VARIABLE REFRIGERANT VOLUME, AIR-COOLED

A. General: The systems shall be installed by a factory trained contractor/dealer. The bidders are required to submit training certification proof with bid documents. The mechanical contractor’s installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors may to arrange training prior to bid day.

B. Outdoor Air Conditioning Units
1. Coordinate and provide supports/anchorages, refrigerant piping connections, controls, power, etc.

C. Indoor Fan-Coil Units
1. Coordinate and provide supports/anchorages, vibration isolation (where required), seismic bracing, outside air duct connections, economizer and filter section (where required), condensate drainage, controls, power, etc.
2. Set in place using manufacturer’s recommended rigging attachments. Mount unit dead level. Anchor unit to structure or to floor. Provide
3. Support ceiling mounted air conditioning unit as indicated, and as recommended by the manufacturer.

D. Refrigerant Piping
1. Make joints with silver brazing of contractor's choice.
2. Overheated joints shall not be permitted. Deformed pipe or fittings, or fittings with scalloped edges or burned fittings shall be removed and replaced. Wire brush all joints to bright metal after soldering. Cut end of pipe square with a pipe cutter and thoroughly clean end of pipe and inside of fittings before soldering.
3. Purge piping before and during brazing with nitrogen.
4. After brazing, quench the joints with water or a wet cloth to prevent overheating of the service valve.
5. Use dry nitrogen to pressure the tubing and indoor coil through the service valve ports located at the condenser. Check for leaks by using an approved bubble solution or other leak checking method. Continue the process until the system has been determined to be leak free.
6. Connect the vapor line and liquid line pressure taps to a vacuum pump and micron meter.
7. Evacuate the refrigerant lines and indoor coil to at least 350 microns. Close off the valve to the vacuum pump and observe the micron meter. If the pressure does not rise above 500 microns in one minute, the evacuation process is complete and the vapor-line and suction line service valves may be open.

8. Support refrigerant pipe at intervals of six feet maximum centers or as instructed by the manufacturer.

9. All Refrigerant specialties and trims shall be sized for the capacity and type of refrigerant specified. Sizes shown on drawing shall be verified. All trim shall be full line size and with sweat connections.

10. Insulate all refrigerant lines.

E. Refrigerant: Furnish and charge the systems with sufficient refrigerant to operate the systems correctly under all conditions. Furnish and charge all replacement refrigerant needed during the guarantee period.

F. Wire all controls and interlocks (included power wiring) between indoor unit and outdoor unit per manufacturer's printed instructions. Supervise power wiring.

G. Refrigerant Pipe and Condensate Drain Insulations: See Section 230700

H. Test and Balance: Test unit in both modes of operation, heating and cooling. Operate the unit at all fan speed for the duration of 60 minutes per each set point.

I. Commissioning: The manufacturer representative shall be responsible for system startup, initial programming and scheduling setup, system checkout, and functional performance test for all units. Provide written report to the Owner’s representative for review and approval.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes chain link fence and gate framework, fabric, hardware and accessories; excavation and concrete foundation for posts and gate center drops; and privacy slats as part of Deductive Alternate(s) described in Construction Documents.

B. Related Sections:
   1. Section 00300 – Bid Proposal Form for Deductive Alternates
   2. Section 01030 – Alternates for Description of Alternates, Deductive Alternates 2.B.3 and 2.B.4
   3. Section 03 30 00 – Cast in Place Concrete

1.2 REFERENCES

A. ASTM International:
   3. ASTM A824 - Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
   5. ASTM F552 - Standard Terminology relating to Chain Link Fencing.

B. Chain Link Fence Manufacturers Institute:
   1. CLFMI - Product Manual.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Requirements for submittals.
B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

C. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.

D. Samples: Submit samples of fence fabric or slat infill if specified, 12 inch minimum dimension, illustrating construction and colored finish.

1.4 QUALITY ASSURANCE

A. Supply material in accordance with CLFMI - Product Manual.

B. Perform installation in accordance with ASTM F567.

1.5 QUALIFICATIONS

A. Manufacturer and Installer: Companies specializing in manufacturing or installing Products specified in this section with minimum three years’ experience.

1.6 DELIVERY, STORAGE AND HANDLING

A. Division 1 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

C. Identify each package with manufacturer’s name.

D. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Furnish compliant products of one of the following or approved equal:


4. Swan Fence Incorporated.

B. System Description: CLFMI Manual-compliant chain link fencing and gates with polymer coated steel framework and fabric, top and bottom rails, and privacy slats. Line post spacing to match Base Bid post spacing as indicated on drawings, and in no case greater than 10 foot post interval.

1. Fabric Height: Match Base Bid enclosure height.
2.2 MATERIALS

A. Polymer Coated Framing (Steel): ASTM F1083 Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 25 ksi; zinc coating conforming to ASTM F1043 Type A on pipe exterior and interior; polymer coating shall be Polyester coating fused and adhered to the exterior zinc coating with minimum 3 mils thickness per ASTM F1043. Color to match fence fabric per ASTM F934.

B. Polymer Coated Fabric Wire (Steel): ASTM F668, zinc coated steel wire per ASTM A392 with 8 gauge Class 2b fused and bonded vinyl coating; wire gauge specified for polymer-coated wire is that of the metallic coated steel core wire. Color: Tan/Beige or Brown as selected by Architect.

C. Concrete: ASTM C94, Option A; Normal Portland Cement, 2,500 psi strength at 28 days. Furnish compliant type specified in Section 03 30 00.

2.3 COMPONENTS

A. Line, Corner and Terminal Posts:
   1. For Fabric Height Up to 8 Feet: 2.375 inch outside diameter round steel pipe weighing not less than 3.65 pounds per foot.

B. Top, Bottom and Brace Rails: 1.66 inch outside diameter round steel pipe weighing not less than 2.27 pounds per foot. Include couplings and fittings as required.

C. Gate Posts:
   1. For Fabric Height of 6 Feet and Less, with Leaf Width 10 Feet and Less: 2.875 inch outside diameter round steel pipe weighing not less than 5.79 pounds per foot.
   2. For Fabric Height of 6 Feet and Less, with Leaf Width Greater than 10 Feet not exceeding 18 Feet: 4.00 inch outside diameter round steel pipe weighing not less than 9.11 pounds per foot.
   3. For Fabric Height Greater than 6 Feet, with Leaf Width Up to 12 Feet: 4.00 inch outside diameter round steel pipe weighing not less than 9.11 pounds per foot.

D. Fabric: 2 inch interwoven mesh, 9 gauge. Furnish fabric less than 72 inches high with knuckling on both selvages. Furnish fabric 72 inches high and over with knuckling at the top selvage and twisting on the bottom.

E. Polymer Coated Tension Wire: Single strand, marcelled, 7 gauge steel, conforming to ASTM A824. Match coating type to that of the chain link fabric.

F. Tie Wire and Hog Rings: 9 gauge galvanized zinc coated steel wire conforming to ASTM F626, polymer coated to match the coating, class and color of the chain link fabric.
2.4 ACCESSORIES

A. Tension and Brace Bands: 12 gauge galvanized pressed steel in conformance with F626; minimum 3/4 inches.

B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: Galvanized pressed steel in conformance with ASTM F626.

C. Truss Rod Assemblies: ASTM F626, galvanized 3/8 inch diameter galvanized steel rods with pressed steel tighteners. Assembly capable of withstanding a tension of 2,000 lbs.

D. Tension Bars: ASTM F626, galvanized steel, one piece 2 inches less in length than the fabric height. Bar width compatible with mesh size.
   1. Attach tension bars for mesh 5/8 inches and smaller to terminal posts using minimum 2 inch wide by 3/16" thick galvanized steel straps and carriage bolts.

E. Privacy Slats: Slats to be manufactured from a combination of color pigments, quality high density virgin polyethylene and ultraviolet inhibitors, having a 25 year limited warranty against either color fading or breakage of slats and locking-channel used under normal climatic extremes experienced in North America. Color to match fence fabric. Slats shall be self-locking type.

2.5 SWING GATES

A. General: Swing gate in direction shown on drawings.
   1. Gate Width: As shown on drawings.
   2. Factory-assemble gates, galvanized steel welded fabrication conforming to ASTM F900. Protect joints by applying zinc-rich paint in accordance with ASTM A780. Finish: Match that of fence system.
   3. Fabricate gates to permit 180 degree swing.

B. Gate Frames: 1.90 inch outside diameter round steel pipe weighing not less than 2.72 pounds per foot.

C. Gate Hardware: Fulcrum style pressed steel latch with accommodation for padlock, galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges.

D. Gate Fabric: Match that of fence system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas scheduled to receive chain link fencing for conditions that will adversely affect execution, performance, or quality of work.
3.2 PREPARATION

A. Lay out fencing, locate posts and gates.

B. Verify elevation of finish grade and establish indicated fence heights above finish grade.

3.3 INSTALLATION

A. Meet requirements of CLFMI - Product Manual unless otherwise indicated.

B. Install framework, fabric, gates, and accessories in accordance with ASTM F567.

C. Posts: Set posts of sizes noted in concrete footings as shown and specified. Set plumb, true to line and layout; brace as required. Crown top of post concrete footings to shed water away from the posts. Set base of crown level with surrounding asphalt or concrete, and 6 inches below grade at soil. Allow concrete to thoroughly set before installing fabric.

   1. Footing Depth: 3'-0" minimum.
   2. Footing Diameter: Four times post diameter.

D. Top Rails: Provide top rails continuously along top of fence; join where necessary with 6 inches long outside sleeves.

E. Horizontal Braces: Provide midway between top rail and ground, and to extend from corner posts to first adjacent line post.

F. Bottom Rails: Provide bottom rails between posts and attach to post using rail end or line rail clamps.

G. Stretcher Bars: Thread stretcher bars through fabric at all terminal, gate, or pull posts.

I. Attach stretcher bar to adjacent posts by band, No. 6 gauge wire, or other positive mechanical means at maximum 15 inch intervals.

J. Fabric:

   1. Place fabric on outside of enclosure.
   2. Cut fabric; trim neat and straight. Fabric shall be cut at all terminal and gate posts.
   3. Do not stretch fabric until concrete foundation has cured 28 days.
   4. Stretch fabric between terminal posts or at intervals of 100 feet maximum.
   5. Position bottom of fabric 2 inches above finished grade unless otherwise indicated.
6. Attach fabric to terminal, corner, and gate posts with stretcher bars and tension bar clips. Exercise care to equalize tension on both sides of all line posts.

7. Fasten top and bottom fabric edges to rails or tension wires (as occurs) with wire ties at maximum 15 inch intervals.

K. Gates:
   1. Support gates from gate posts. Do not attach hinged side of gate from building wall.
   2. Install gates to open 180 degrees if possible; to operate easily without binding, sticking, or sagging.
   3. Align latches and keepers for proper function.
   4. Stops and keepers shall be set flush in concrete, located to minimize tripping hazard.

L. Privacy Slats: Install and lock in privacy slats in the fabric in accordance with manufacturer’s instructions.

M. Finished work shall be properly located and aligned with all wires and fasteners drawn tight.

3.4 ERECTION TOLERANCES

A. Division 1 - Quality Requirements: Tolerances.

B. Maximum Variation From Plumb: 1/4 inch

C. Maximum Offset From Indicated Position: 1 inch

D. Minimum distance from property line: 6 inches.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install all site furnishings shown on drawings and specified in accordance with the manufacturer's instructions and as shown on the drawings and as specified.

B. Related requirement specifications elsewhere:
   1. Section 32 13 00, SITE CONCRETE
   2. Section 32 90 00, PLANTING

1.2 REFERENCES

A. Perform work in accordance with all applicable laws, codes and regulations required by the City and the State of California.

B. Manufacturer’s Instructions:
   1. Where required in the Specifications that materials, products, processes, equipment or the like to be installed or applied in accordance with manufacturer's instructions, directions or specifications, or words to this effect, it shall be constructed to mean that said application or installation shall be in strict accordance with printed instructions furnished by the manufacturer of the material for use under conditions similar to those at the job site.
   2. All site furnishings shall be anchored or otherwise secured to prevent movement, unless stated otherwise. Provide concrete footings, corrosion resistant clips, etc. as accepted by the Owner's Representative.

C. Reference Standards:

1.3 COORDINATION

A. Coordinate items of other trades. Contractor shall be responsible for the proper installation of all accessories embedded in concrete and for the provision of connections, holes, openings, etc., necessary to the execution of the work of the trades.

1.4 SUBMITTALS: Section 01 33 00

A. Submit the following for approval:
   1. Product cut sheets with materials and colors as listed on the drawings
   2. Submit color chips for all materials
3. **Shop drawing for custom site furnishings.**

**PART 2 - MATERIALS**

2.1 Refer to drawings and Site Furnishings Schedule for all makes and models and sizes.

**PART 3 - EXECUTION**

3.1 **GENERAL INSTALLATION**

A. Install manufactured items in accordance with the manufacturer's instruction and as shown in the drawings and as specified herein.

B. Perform all work in accordance with all applicable laws, codes and regulations required by State of California and the City of Brentwood.

C. Set all work true and square, plumb and level. Remove and replace any wood that splits during or after erection until acceptance. Keep nailing neatly lined up.

D. Fabricate wood in as long pieces as practical unless otherwise indicated. End joints shall occur at supports. Keep all work clean, accurately cut, closely fitted and set to the required lines and levels. Blunt exposed edges by sanding or with plane.

E. Place washer under the head and nut of bolts where same bear on wood, except head of carriage bolt. Drill bolt holes same diameter as bolt.

F. Size bolts to fit flush with nuts. Countersink nuts and bolts as detailed.

G. Hammers with scored faces shall not be used in nailing.

H. Supply all miscellaneous metal units and install as specified herein under the Sections entitled "Miscellaneous Metalwork" and "Galvanizing." Hot-dip galvanize all metal fastenings, angles, etc., after complete fabrication.

I. Galvanized metal that is cut, damaged or modified after fabrication shall be immediately painted with Zinc-rich paint to prevent rusting.

J. Touch up paint any damaged surfaces to match original finish as accepted by Owner's Representative.

K. Set site furniture, level. Provide spacers under furniture to level as specified herein and acceptable to Owner’s Representative

L. Transport, store and handle precast units and manufactured items in a manner to avoid hairline cracks, staining or other damage. Store units free of the ground and protected from mud or rain splashes. Cover units, secure covers firmly, and protect the units from dust, dirt or other staining material.
3.2 BENCHES
   A. Install level and in accordance with the manufacturer's instruction and as shown.

3.3 TABLES
   A. Install level and in accordance with the manufacturer's instruction and as shown. Provide spacers under furniture to level as specified herein and acceptable to Owner's Representative.

3.4 TRASH RECEPTACLES
   A. Install level and in accordance with the manufacturer's instruction and as shown. Provide spacers under receptacles to level as specified and acceptable to Owner’s Representative.
   B. Shop drawings to include vinyl signs and color and door and body finish.

3.5 BIKE RACK
   A. Install in accordance with the manufacturer's instruction and as shown.
      1. Core drill 3” diameter holes 6” deep. Core drills with larger diameters to be reviewed by Owner’s Representative.

3.6 BIKE LOCKER
   A. Install in accordance with the manufacturer's instruction and as shown.

3.7 BOLLARD
   A. Install in accordance with the manufacturer's instruction and as shown.

3.8 CLEANUP, per Section 01 77 00.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. The work in this section consists of furnishing, layout and installing an irrigation system complete, including certification of irrigation system installation as required by the State of California Model Water Ordinance described herein.

B. Related work specified elsewhere includes:
   1. Section 20 00 00, BUILDING AUTOMATION SYSTEM
   2. Section 31 20 00, EARTHWORK.
   3. Section 32 90 00, PLANTING.
   4. Section 26 00 00, ELECTRICAL stub-out(s) for controller(s).

1.2 CALIFORNIA MODEL WATER EFFICIENT LANDSCAPE ORDINANCE REQUIREMENTS

A. Contractor shall be familiar with and follow the State of California Model Water Ordinance, California Code of Regulations, Title 23 Waters, Division 2, Department of Water Resources, Chapter 2.7. Also, the Contractor is responsible to follow all local water ordinances.

B. Pursuant to the requirements of the California Model Water Efficient Landscape Ordinance, the Contractor shall submit a Certification of Installation to the Local Jurisdiction /water purveyor as described in the construction documents and these specifications. Certification shall at a minimum include the following documents:

   PART 1. Project Information Sheet
   PART 2. Certification of Installation according to the landscape documentation package.
   PART 3. Irrigation Scheduling and Controller Programming
   PART 4. Schedule of Landscape and Irrigation
   PART 5. Landscape Irrigation Audit Report
   PART 6. Soil Management/Analysis Report with verifying implementation, see Planting Specification for analysis requirements.

1.3 QUALITY ASSURANCE

A. Manufacturer's Specifications: Follow manufacturer's current printed specifications and drawings in all cases where the manufacturers of articles used in the Contract furnish directions covering points not specified or shown in the drawings.

B. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the
same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard, or larger size than is required by the above codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.

C. References, Codes and Standards:

2. California Environmental Quality Act (CEQA)
3. Water Use Classification of Landscape Species (WUCOLS).
6. CAL-OSHA, title 8, Subchapter 4-Construction Safety Orders and Subchapter 7-General Industry Safety Orders.
8. California Plumbing Code (UPC) published by the Association of Western Plumbing Officials.
9. NFPA 24, Section 10.4, Depth of Cover.
10. Underwriters Laboratories (UL): Electrical wiring, controls, motors and devices, UL listed and so labeled.

D. Furnish without extra charge any additional material and labor when required by the compliance with all above mentioned codes and regulations, though the work be not mentioned in these specifications or shown on the drawings.

E. Reclaimed Water: Contact water company supplying reclaimed water prior to the commencement of installing the irrigation system to coordinate inspection of the work and to verify all codes and regulations regarding use of reclaimed water. Provide all required signage and other warnings.

F. Experience: Assign a full-time employee to the job as supervisor for the duration of the Contract with a certified landscape technician, irrigation certification through CLCA or minimum of four (4) years experience in landscape irrigation installation.

G. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work to be accomplished to perform the task in a competent, efficient manner acceptable to the Owner's Representative.

H. Explanation of Drawings:
1. Due to the scale of the Drawings, it is not possible to indicate all piping offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affected all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities and architectural features.

2. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in arc dimensions exist that might not have been considered in engineering. Bring such obstruction or differences to the attention of the Owner’s Representative. Notify and coordinate irrigation Work with applicable contractors for location and installation of piping and sleeves through or under walls, pavement and structures. In the event this notification is not given, the Contractor shall assume full responsibility for any revision necessary.

I. Coordinate plant locations with emitter locations.
   1. Adjust plant locations in relation to the subsurface emitter s as required to ensure that the plant roots receive the proper amount of water in order for it to thrive.
   2. Coordinate planting and irrigation and provide hand watering of emitter irrigated and drip irrigated areas as required to maintain moist root zones until end of plant establishment period.

1.4 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. The Drawings show, if applicable, existing above and below grade structures and utilities that are known to the Owner. Locate known existing installations before proceeding with construction operations that may cause damage to such installations. Existing installations shall be kept in service where possible and damage to them shall be repaired with no adjustment of Contract Sum. Verify with Owner if As Built drawings are available.

B. If other structures or utilities are encountered, request Owner's Representative to provide direction on how to proceed with the Work. If a structure or utility is damaged, take appropriate action to ensure the safety of persons and property.

1.5 SUBMITTALS, in accordance with Section 01 33 00.

A. Materials List:
   1. Submit required copies of the cut sheets and a complete list of materials proposed for installation, along with any proposed substitutions clearly identified and obtain the Owner Representative's written approval thereof before proceeding. Use only accepted materials and items of equipment.
   2. List all materials by manufacturer's name and model number.
   3. Submit to Local Water Purveyor with copy to the Owner Certification of Installation as required by the State of California Model Water Ordinance.
B. Substitutions:

1. If the Contractor desires to substitute a product, he shall list each item and note it as a "substitution" and provide the following information:
   
   a. Descriptive information describing its similarities to the specified product.

2. If the product is approved and, in the opinion of the Owner's Representative, the substituted product does not perform as well as the specified product, the Contractor shall replace it with the specified product at no additional cost to the Owner.

C. Operations and Maintenance Manuals:

1. Prior to the final acceptance of the irrigation system, furnish three (3) individually bound Operation and Maintenance Manuals to the Owner's Representative for use by the Owner. The manuals shall contain complete enlarged drawings, diagrams and spare parts lists of all equipment installed showing manufacturer's name and address. In addition, each Service Manual shall contain the following:

   a. Index sheet indicating the Contractor's name, address and phone number.

   b. Copy of the Landscape Irrigation Audit

   c. Copy of the 12-month irrigation schedule and estimate of annual water consumption

   d. Copies of equipment warranties and certificates.

   e. List of equipment with names, addresses and telephone numbers of all local manufacturer representatives.

   f. Complete operating and maintenance instructions in sufficient detail to permit operating personnel to understand, operate and maintain all equipment.

   g. Parts list of all equipment such as controllers, valves, solenoids and heads.

D. Record Drawings:

1. Dimension the location of the following items from two (2) permanent points of reference such as building corners, sidewalks, road intersections, etc.:

   a. Connection to existing water lines/meter.

   b. Connection to electrical power.

   c. Gate valves.

   d. Routing of sprinkler pressure lines (a dimension at least every 100 feet and as required to identify all changes in direction and location).

   e. Remote control valves.

   f. Routing of control valves.
g. Quick coupling valves.

h. All sleeve locations.

i. Routing of all control wiring.

j. Include all invert elevations below 12”.

2. Deliver a reproducible record drawing to the Architect within seven (7) working days before the date of final review. Delivery of the record drawings shall not relieve the Contractor of the responsibility of furnishing required information in the future.

E. Controller Plan:

1. Provide one Irrigation Diagram plan in each controller housing. The plan shall show the area controlled by each valve in different colors and for orientation, any major permanent structure such as buildings and roads.

2. Charts to be waterproof and hermetically sealed between two pieces of transparent 10 mil thick plastic and installed in each controller on the door as accepted by the Owner's Representative no later than the time of the coverage test of the irrigation system.

F. Maintenance Material - supply the following tools to the Owner:

1. Three (3) sets of specialized tools required for removing, disassembling and adjusting each type of sprinkler, valve or other equipment supplied on this project.

2. Two (2) keys for each type of equipment enclosure.

3. Two (2) keys for each type of automatic controller.

4. Two (2) keys for each type of valve (including square type key for valves larger than 2”)

5. Two (2) quick-coupler keys and matching hose swivels for each type of quick-coupling valve installed.

6. All lock keys shall be keyed alike.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish and deliver materials in manufacturer's packaging, bearing original legible labeling.

B. The Contractor is cautioned to exercise care in handling, loading, unloading, and storing PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of the pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented, cracked, or otherwise damaged shall be discarded and, if installed, shall be replaced with new piping.
1.7  SEQUENCING AND SCHEDULING

A. Acceptance: Do not install main line trenching prior to acceptance by Owner's Representative of rough grades completed under another Section.

B. Coordination: Coordinate with the work of other sections to insure the following sequence of events:

1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving and through walls prior to placement of those materials.

2. Bubbler Heads: Install after placement of tree, but prior to backfill with planter soil mix.

3. On-Structure Equipment: Install piping and risers after waterproofing is accepted.

4. Sprinkler Head in Pots: Install riser and seal the penetration of the pot prior to backfill of pot with drainage materials and planter soil mix.

5. Coordinate work schedule with Owner to avoid disruption of landscape maintenance of existing landscaping.

6. Install piping prior to soil preparation (planting soil amendment installation).

1.8  WARRANTY, per Section 01 78 36.

A. In addition to manufacturer's guarantees and warranties, work shall be warranted for one (1) year from date of final acceptance against defects in material, equipment and workmanship. Warranty shall also cover repair of damage to any part of the premises resulting from leaks or other defects in materials, equipment and workmanship to the satisfaction of the Owner.

B. Include a copy of the warranty form in the Operation and Maintenance Manual.

1.9  OPERATION

A. Routine: Inspect and adjust all spray heads and control valves including raising or lowering of spray head heights to accommodate plant growth and weather conditions.

B. Controller: Inspect regularly for power interruption and reset clock as required. Adjust station timing to accommodate changes in plant growth and weather conditions.

C. System Failure: Perform all repairs within one (1) operating period. Replacements to match removed products and materials in all respects. Report promptly all damage not resulting from Contractor's operations. Repair all damage caused by Contractor at no expense to Owner.

D. Climate Change: Set and program automatic controllers in response to seasonal requirements and requirements of newly planted materials.
PART 2 - PRODUCTS

2.1 PIPE

A. Pressure Main Line Pipe and Fittings: All PVC fittings shall bear the manufacturer's trademark name, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

B. All main line pipe shall be solvent welded and shall be schedule 40 unless shown otherwise on the Drawings.

C. All main line pipe shall be solvent welded and manufactured from purple-colored PVC material and shall be printed on two sides with the wording "CAUTION-RECLAIMED WATER" every 24 inches along pipe.

1. PVC Pressure Rated Pipe: ASTM D2241 NSF approved Type I, Grade I, solvent welded PVC with an appropriate standard dimension ratio (S.D.R.).

2. PVC Scheduled Pipe: ASTM D1785 NSF approved, Type I, Grade I, solvent welded PVC.


4. Solvent Cement and Primer for PVC solvent-weld pipe and fittings: Type and installation methods prescribed by the manufacturer.

5. Connections between Main Lines and RCVs: Schedule 80 PVC (threaded both ends) nipples and fittings unless required otherwise by local jurisdiction.

6. Valves 2-inch and larger shall be flanged only.

7. Copper pipe shall be Type K or Red Brass where threaded joints are required and Type L otherwise.

D. All lateral line pipe shall be solvent welded and shall be schedule 40 unless shown otherwise on the Drawings.

E. All lateral line pipe shall be solvent welded Schedule 40 manufactured from purple-colored PVC material and shall be printed on two sides with the wording "CAUTION-RECLAIMED WATER" every 24 inches along pipe.

2.2 CONTROLLER ENClosures

A. As recommended by the controller manufacturer

2.3 REMOTE CONTROL VALVE: As shown on Drawings and with the following minimum requirements:

A. Remote control valves shall be those normally manufactured for irrigation systems and shall have a slow, consistent speed of closure through entire closing operation, including last portion. To ensure this, the effective diaphragm working area/valve seating opening ratio must be a minimum 3 to 1.
B. Shall be mechanically self-cleaning to help prevent diaphragm or solenoid port plugging. To ensure this, the flush rod should be tapered to vary the size of the port opening as the diaphragm raises and lowers, thus allowing trapped material to escape. Rod is to be finished with a serrated surface to help scrub trapped material out. Screens not acceptable.

C. Shall have removable valve seat so valve can be repaired without removal from irrigation line.

D. Shall have ability to operate manually without the use of wrenches or special keys.

E. Shall have one-piece solenoid that attaches directly to valve without shunts or clips that can be lost.

F. Shall have cross top handle to adjust maximum travel of diaphragm to allow "tuning" of valve and closure.

G. Remote control valve to contain non potable purple cap.

2.4 BOX FOR REMOTE CONTROL VALVE Designer Note: Black boxes with black lids are more attractive in the landscape. You may want to check if the owner has a preference. Purple lids are required for non-potable water, and some agencies may require purple in anticipation of a future recycle water supply, even if they are currently using a domestic supply.

A. Rectangular black plastic valve box - Ametek, Carson, Christy, Rain Bird or accepted equal with non-hinged bolt down black (purple for non potable water) colored lid marked "irrigation" (and with bilingual non-potable warning and symbol). Box body shall have knock outs. Do not saw cut body. The minimum size box is as shown on Drawings. Increase box size as required to fit. Valve box lids are to indicate the controller letter and station number of valve as accepted by Owner's Representative. Also refer herein to required polyurethane tag at valve solenoid control wire under Control Wires. Locate the identification in center of the lid. Provide separate box for each valve. Provide H/20 Loading concrete boxes with bolt-down concrete lids for all valves that occur in paved areas.

2.5 CONTROLLER GROUND

A. Provide each pedestal controller with its own ground rod. Separate the ground rods by a minimum of eight feet. The ground rod shall be an eight foot long by 5/8" diameter U.L. approved copper clad rod or as recommended by controller manufacturer. Install no more than 6" of the ground rod above finish grade. Connect #8 gauge wire with a U.L. approved ground rod clamp to rod and back to ground screw at base of controller with appropriate connector. Make this wire as short as possible, avoiding any kinks or bending. Install within pedestal housing base unless otherwise noted.

B. Provide each irrigation controller with its own independent low voltage common ground wire.
2.6 CONTROLLERS(S): As shown on Drawings and with the following minimum requirements:

A. System shall be 2-way central internet management capable with remote programming, and daily ET weather data.

B. Communication via mobile device with real-time notification of field alerts anywhere internet access can be obtained.

C. Controller to measure and trend water usage and report to BAS/BMS. Controller manufacturer to work with District to scope out level of integration.

2.7 GENERAL REQUIREMENTS FOR AUTOMATIC CONTROLLERS & CENTRAL: Work includes a complete and efficient sprinkler irrigation control system ready for use, including, but not limited to: central irrigation software and hardware, laser printer, satellite field controllers, flow meters, master valves, and wiring. This intention is to be met foregoing any deficiency in these plans and specifications.

A. Flow Sensors: Compatible with Central Control System and as recommended by Control System manufacturer.

B. Flow Monitors: Compatible with Central Control System and as recommended by manufacturer.

C. Hand Held Remote Control: Portable device as manufactured by Control System manufacturer capable of operating all control valves.

D. Master Control Valve: Master control valve shall be a 24 VAC, industrial type, solenoid control valve, Griswold 2000 series or equal, sized for specified mainline size. Valve shall be equipped with spring loaded packless diaphragm, cast iron body and bronze trim. The valve shall be of the normally closed open type and shall be equipped with four-prong (cross) flow control. Valve shall be slow closing without chatter settings or adjustment. Valve shall have a mechanical self-purging internal control system with tapered, serrated, scrubbing rod through diaphragm for positive, variable port opening and cleaning. No solenoid port screens. Valve solenoid shall be corrosion-proof, molded in epoxy to form one integral unit with no connection shunts and shall be 24 VAC, 3 watt maximum.

E. Controller Ground:

1. Provide each pedestal controller with its own ground rod set remote from controller as recommended by controller manufacturer. Separate the ground rod by a minimum of eight feet. The ground rod shall be an eight foot long by 5/8" diameter U.L. approved copper clad rod or as recommended by controller manufacturer. Install no more than 6" of the ground rod above finish grade. Connect #8 gauge wire with a U.L. approved ground rod clamp to rod and back to ground screw at base of controller with appropriate connector. Make this wire as short as possible, avoiding any kinks or bending. Install within pedestal housing base unless otherwise noted.
2. Provide each irrigation controller with its own independent low voltage common ground wire.

2.8 CONTROL WIRES

A. Connections between automatic controllers and the solenoid-operated electric control valves shall be made with direct burial copper wire 14- AWG-UF 600 volt (minimum size). Pilot wires shall be a color other than white, and shall be a different color for each automatic controller with wires sharing a common trench. Common wires shall be white in color, with a different color stripe for each controller with wiring sharing the same common trench. No stripe is required if multiple controller wiring is not present.

B. Size of wire shall conform to the remote control valve manufacturer's specification for control wire sizes, but in no case shall the control wire be smaller than #14. Runs over 2,000 lineal feet shall be #12- AWG-UF 600 volt copper wire.

C. All wire splices are to be made within a valve box, with a copper crimp-type connector, and a "3-M" #DBY splice kit or Rain Bird “DBTWC25”.

D. Use continuous control wiring between controllers and remote control valves (no splices).

E. Provide polyurethane tag at valve solenoid control wire that shows the controller number and station number. Also refer to valve box lid identification.

F. Provide a spare control wire in each RCV box for future.

2.9 SPRAY HEADS

A. Pop-up as shown on drawings and with the following minimum requirements:

B. Shall have approximately 30 psi water pressure coming out of nozzle to prevent "fogging" or misting. Shall have pressure-compensating devices.

C. Shall have ability to prevent low head drainage. Use heads with integral check valves.

D. EXAMPLE – Rain Bird 1800 Spray Body with SAM -PRS Series

E. Shall not have spray blocked by turf or shrubbery; use minimum 4" pop-ups in turf areas.

F. Spray to contain purple non potable cover/cap

2.10 ROTOR HEADS

A. As shown on drawings and with the following minimum requirements:

B. Heads shall have exact matched precipitation rates. Radius and precipitation rates must be the same.

C. EXAMPLE Hunter MP Rotator Series with MPR, PRS and SAM
D. Rotor to contain purple non-potable cover/cap

2.11 BUBBLER HEADS
   A. As shown on drawings

2.12 QUICK COUPLER VALVES:
   A. Quick coupler valves shall be equipped with purple covers. Box shall have purple color lid (unless noted otherwise), with marked “irrigation” and with bilingual non-potable warning and symbol

2.13 ISOLATION VALVE:
   A. Valves 3 inches and smaller: WSP bronze ball valve with screw-in bonnet, non-rising stem and solid wedge disc, NIBCO, Griswold or approved equal. Valves shall be line size.
   B. Valves larger than 2”: shall have square nut stem and o-ring connections for key operation.

2.14 DRIP IRRIGATION
   A. Drip Manifold:
      1. Pressure Regulator: Preset at 30 psi outlet pressure, ¾” female threaded inlet and outlet, by RainBird, Toro or equal.
      2. Emitters: Xeri-Bug (XB Series) by RainBird, Toro EZ Drip Series, or equal.
      3. Flexible PVC: ASTM D2287 algae-resistant flexible PVC as recommended by manufacturer of Drip Emitters.
      4. Drip tubing: Conform to A. S. A. E. standards for minimum inside diameter and wall thickness, Minimum 2% carbon black, Salco ¾” AR Drip PVC flexible drip hose, or equal.
      5. ¾” Y-filter, 200 mesh.
      6. Toro DL 2000 Air/Vacuum Relief Valves and In-line Spring Check Valves.
      7. ¾” manual PVC ball valve with extra 3’ of hose coiled in valve box.
      8. Drip system in accordance with “RainBird Xerigation Low-Volume Landscape Irrigation Design Manual” and as shown on the drawings as required for a complete working system.
      9. Drip tubing, flush cap and diffuser cap to be non-potable purple color.
2.15 SUBSURFACE DRIP IRRIGATION:

A. As specified herein and as shown on the drawings and in accordance with manufacturer’s recommendations. Provide all miscellaneous valves, filters fittings etc. required for a complete, operable system including the following:

1. Emitters shall be Rain Bird XF-SDI with “Copper Shield” technology. Drip system in accordance with “RainBird Xerigation Low-Volume Landscape Irrigation Design Manual” and as shown on the drawings as required for a complete working system.


B. Drip Valve Assembly: Size valve box large enough and deep enough to contain assembly and allow convenient access and easy removal of filter screen. Position filter pointed down, approximately 45 degrees.

C. Pressure regulator: Size regulator in accordance with flow rate. Do not over size. Use factory pre-set regulator at 30 PSI.

D. Subsurface dripline tubing flush cap, and diffuser cap to be non-potable purple color.

2.16 BOX FOR ISOLATION VALVE

A. 10” diameter black plastic, Ametek, Brooks, Christy, Rain Bird with bolt down black lid marked “irrigation,” or accepted equal. Avoid locating valve in paved areas. Provide H/20 Loading concrete box with bolt-down concrete lid if valve is located in paved area. Obtain location approval by Owner’s Representative.

B. Isolation valves shall be equipped with purple covers. Box shall have purple color lid (unless noted otherwise), with marked “irrigation” and with bilingual non-potable warning and symbol

2.17 SWING JOINTS

A. Sprinklers and Bubblers: Use Dura, Lasco, Rain Bird or equal pre-assembled swing joints with O-rings.

B. Quick Coupling Valve: Dura 1-inch 1-A2-1-11-18 pre-assembled swing joint with O-rings and Dura quick lock to receive stabilizing rod.

2.18 BACKFLOW PREVENTION DEVICE

A. As required by Code and as shown on Drawings. Verify with Owner if Anti-freeze Jacket is required and provide as required.
B. Riser assemblies from main line burial depth to backflow preventers shall be Schedule 40 brass pipe.

C. All metallic pipe and fittings installed below grade shall be painted with two coats of Koppers #50 Bitumastic, or approved equal. Pipes may be wrapped with an approved asphaltic tape in lieu of the liquid-applied coating.

D. Backflow preventer shall receive a minimum 6 inch thick concrete coordinated to fit backflow preventer enclosure as shown and as accepted by the Landscape Architect.

2.19 BACKFLOW PREVENTION DEVICE ENCLOSURE

A. “Smooth Touch” enclosure without sharp edges, by Strong Box, available from V.I.T., Escondido, CA (800) 729-1314 or equal. Coordinate size of enclosure with plumbing for minimum clearance and size. Enclosure to include concrete footing with hasp and staple to receive padlock. Padlock N.I.C.

2.20 CONDUIT/SLEEVES

A. Sleeving shall be Schedule 40 PVC pipe sleeves and a minimum of two times the aggregate diameter of all pipes contained within the sleeve. Provide vertical sweep for all electrical conduit on each side of hardscape and terminate ends at 12" minimum depth and 12" from hardscape surface.

2.21 Y-STRAINER

A. “Y”-Strainer upstream of remote control valves, Brass, 100 mesh.

2.22 RCV IDENTIFICATION TAGS: Plastic or brass tags with valve number, approximately 2" by 2" with number imprinted, as accepted by Owner.

2.23 MISCELLANEOUS INSTALLATION MATERIALS

A. Solvent Cement and Primers for Solvent-weld Joints: Make and type approved by manufacturer(s) of pipe and fittings. Maintain cement proper consistency throughout use.

B. Pipe and Joint Compound: Permatex: Do not use on sprinkler inlet port.

2.24 MISCELLANEOUS EQUIPMENT/ACCESSORIES

A. Concrete for equipment pads (and thrust blocks if Bell-Type Pipe with O-Rings is required): Poured-in-place Class A concrete per Section 90 of the Caltrans Standard Specifications.

B. Sleeves and Conduits: See Drawings.

C. Key(s) for Quick-Coupling Valves:
1. Type: Same manufacturer as Quick-Coupling Valve.

2.26 OTHER EQUIPMENT: As shown on Drawings and required for a fully functional irrigation system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Sleeves and Conduits: Verify that all installed sleeving and conduits are undisturbed and are free of defects or errors introduced by the work of other sections.

B. Water Meter/Water Pressure: Test and verify that existing water pressure is the minimum pressure at maximum system g.p.m. to operate the irrigation system as indicated on the drawings.

C. Stub-outs: Verify that all stub-outs to be provided under another contract are correctly sized, located and installed as noted on Drawings.

D. Notification: Submit written notification to Owner's Representative within ten (10) working days of above inspections describing all acceptable and non-acceptable site conditions.

3.2 CONNECTIONS TO SERVICES

A. Provide and coordinate connection to water meter.

B. Provide and coordinate connection of irrigation controller to electrical power source.

3.3 INSTALLATION

A. Install irrigation system components in accordance with this Section, with the Drawings, with the manufacturer's recommendations, and with established industry standards. The Contractor shall do nothing that may jeopardize any manufacturer warranty.

B. Conduits and Sleeves:

1. Coordination: Provide conduits and sleeves and coordinate installation with other trades.

2. Extent: Install conduits and sleeves where control wires and pipes pass under paving or through walls as shown on Drawings. Extend twelve inches (12") beyond edges of paving and walls and cap ends until ready for use.

C. Excavating and Trenching:

1. Dig trenches wide enough to allow a minimum of three inches (3") between parallel pipe lines. Provide a minimum cover from finish grade as follows:
a. 24-inches Deep: Over pipe on pressure side of irrigation control valve, control wires and quick-coupling valves.

b. 36-inches Deep: Over all pipe and pipe sleeves under roadways, parking lots, entrance to parking lots and Fire-Access Lanes per NFPA 24, Section 10.4.4.

c. 18-inches Deep: Over pipe on non-pressure side of irrigation control valve.

d. Direct Burial PVC Piping Under Pavement: Provide a minimum of 4 inches of sand backfill on all sides and 24 inches cover to bottom of paving.

D. Pipeline Assembly:

1. Install pipe and fittings in accordance with manufacturer’s current printed Specifications.

2. Clean all pipes and fittings of dirt, scale and moisture before assembly.

3. Solvent-welded Joints for PVC Pipes:
   a. Solvents: Use solvents and methods specified by pipe manufacturer.
   b. Curing Period: Minimum of one (1) hour before applying any external stress on the piping and at least 24 hours before placing the joint under water pressure.

4. Threaded Joints for Plastic Pipes:
   a. Use Permatex on all threaded PVC fittings except sprinkler heads and quick coupler valve ACME threads.
   b. Joining: Use strap-type friction wrench only. Do not use metal-jawed wrench. Assemble finger tight plus one or two turns.

5. Laying of Pipe:
   a. Bedding On-grade: Remove from trench all rocks or clods. Bed pipe in at least 2 inches of soil excavated from trench. Backfill on all sides of piping to provide a uniform bearing.
   b. Snaking: Snake pipe from side to side of trench bottom to allow for expansion and contraction. Minimum allowance for snaking is one (1) additional foot per 100 ft. of pipe.
   c. Moisture Restrictions: Do not lay PVC pipe when there is water in the trench. Do not assemble PVC pipe unless the pipe is dry.

E. Control Valves:

1. Install in valve boxes where shown on Drawings and group together where practical. Install box flush with finish grade, not necessarily level. If valve occurs in drainage swale, relocate out of drainage swale as approved by Owner’s Representative.
2. Where two or more valves are installed adjacent to each other, provide at least six inches (6") separation. Align boxes in a row, perpendicular with pavement edge.

3. Permanently mark valve box lid with 2" black valve number and controller letter or with numbered metal tag inside box as approved by Owner's Representative.

4. Refer to control wiring for required spare wire in each valve box.

F. Install “Y”-Strainer upstream of remote control valves at backflow preventer with two pressure gauges, one upstream and one downstream of each strainer/filter.

G. Sprinkler Head Installation:
   1. Pop-up Heads:
      a. Place all sprinkler heads in planting areas with top of heads set to finish grade or top of mulch as required.
      b. Place part-circle pop-up sprinkler heads two inches (2") from edge of and flush with top of adjacent walks, header boards, curbs and mowing bands or paved areas and 12 inches (12") from building foundations at time of installation.
      c. Set all sprinkler heads in turf to allow for settlement. Adjust as required after settlement. Hold heads two inches (2") clear of pavement edge.

2. Bubblers:
   a. Coordinate installation with planting contractor to insure timely and proper placement of heads at new planting.

H. Subsurface Irrigation
   1. Coordinate plant locations with emitter locations. Refer to QUALITY ASSURANCE herein.
   2. Coordinate hand watering of emitter irrigated and drip irrigated areas. Refer to QUALITY ASSURANCE herein.
   3. Coordinate emitter spacing with planting types and plant spacing as accepted by Landscape Architect. Install emitters at uniform 18 inches on center maximum and 2 to 4 inches deep, except where emitter spacing and depth is shown otherwise.
   4. In Turf in raised (podium) planters and similar sandy soil planting areas, install emitters at uniform 12 inches on center maximum and 3 inches deep, except where emitter spacing and depth is shown otherwise.
   5. Adjust spacing on slopes to prevent over watering at base of slopes. Install system in accordance with “Toro DL-2000 Low-Volume Irrigation Bidding Specifications and Design Details” and as shown on the Drawings as required for a complete working system.
   6. Provide air/vacuum relief valves at all high points on systems.
7. Provide filter as shown and as recommended by emitters manufacturer.
8. Tape pipe ends during installation and do not allow dirt or debris to enter pipe.
9. Use emitter line with the specified emitter flow rate and emitter spacing. Assemble dripper line to allow water to flow continuously and directly, with no dead ends or dead end loops between control valve and flush valve.
10. Use fittings at sharp bends and do not allow dripper line to kink.
11. Install emitter line around perimeter of planter not more than 3 inches off edge for ground cover and turf, 18 inches maximum for shrub planting.
12. Adjust alternate rows so emitters are spaced in a triangular pattern.
13. Collect water from multiple dripper lines and convey the water to automatic line flush valve.
14. Install flush valve at end(s) of collector laterals so that entire system will flush and be free of dirt and debris.
15. Flush valves shall be open when water is turned on for the first time and after a break in the main or lateral lines. Extend collector lateral as required and locate flush valve at convenient accessible location.
16. Flush the systems weekly through the first month of the maintenance period.
17. Thoroughly saturate soil prior to planting. Provide additional surface watering as required to keep plant root systems moist during planting establishment period.

I. Drip Irrigation:
1. Install system in accordance with “RainBird Landscape Irrigation Design and Specifications Xerigation Products and Details” or equal and as shown on the Drawings as required for a complete working system.
2. Install Toro DL 2000 Air/Vacuum Relief Valves at high points in system.
3. Install manual PVC ball valve with extra 3’ of hose coiled in valve box at end(s) of collector laterals so that entire system will flush and be free of dirt and debris.

J. Automatic Controller:
1. General: Install with lock box cutoff switch per local code and manufacturer’s current printed specifications. Provide each controller with its own independent low voltage common ground wire.
2. Connection to Valves: Connect remote control valves to controller in clockwise sequence to correspond with station setting beginning with Stations 1, 2, 3, etc.
3. Labeling: Affix controller letter (i.e., "A") on inside of controller cabinet door with minimum of one-inch (1") high permanent letter.
4. Irrigation Diagram: Affix a non-fading, waterproof copy of irrigation diagram to cabinet door below controller name. Irrigation diagram to be sealed between two plastic sheets, 20 mil. minimum thickness. Use a legible reduced copy of the
Record Drawing for the irrigation diagram clearly showing all valves operated by the controller, station, number, valve size, and type of planting irrigated. Color code area operated by each valve.

K. Control Wiring:
1. General: Install control wires in common trenches with sprinkler mains and laterals wherever possible. Lay to the bottom side of pipe line. Provide looped slack at valves. Snake wires in trench to allow for contraction of wires. Tie wires in bundles at 10 ft. intervals.
2. Extra Length: Provide 30 inches (30") extra control wire at each remote control valve splice to facilitate the removal of the remote control bonnet to finish grade without cutting wires.
3. Spare: Install one unconnected spare control wire running from the controller through each intermediate control valve box.
4. Size: Minimum size of wire is to be determined strictly by the manufacturer's current printed specifications for remote control valves, but not smaller than #14.
5. Detection Wire: Install a bare #12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search. Install the control wires on the bottom of the PVC supply line with electrical tape every ten feet (10').
6. Splicing: Crimp control wire splices at remote control valves. Seal with specified splicing materials. In-line splices will be allowed only on runs exceeding 2500 feet and only in junction boxes.

L. Closing of Pipe and Flushing of Lines:
1. Capping: Cap or plug all openings as soon as lines have been installed to prevent entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.

M. Rain Shutoff Switch:
1. Install switch in area not affected by irrigation or rain shadow. Provide wires in rigid conduit as accepted by Owner’s Representative.

N. Detection Wire and Warning Tape:
1. Install a bare # 12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search.
2. Install a continuous PVC irrigation mainline warning tape 12” above the supply line.

O. RCV IDENTIFICATION TAGS: Install in remote control valve box as recommended by manufacturer and as accepted by Owner’s Representative.
3.4 MISCELLANEOUS EQUIPMENT

A. Install miscellaneous equipment with concrete footings, brackets, etc., as required and as recommended by manufacturer.

3.5 FIELD QUALITY CONTROL

A. Testing of Irrigation System:

1. Make hydrostatic tests with risers capped when welded PVC joints have cured at least 24 hours. Center load piping with backfill to prevent pipe from moving under pressure. Keep all couplings and fittings exposed.

2. Install two (2) pressure gauges at opposite ends of main line system. Pump system up to a minimum of 125 psi the day preceding the scheduled test and verify that pressure is holding. Inspect system early following day and immediately notify Owner's Representative if the test confirmation must be postponed.

3. Apply continuous static water pressure of 125 psi in accordance with Caltrans Standard Specifications Section 20-5.03H, except after a drop in pressure (5 psi maximum), then the pressure must stabilize and remain stable for a one (1) hour minimum period before acceptance of the test.

4. Leaks detected during tests shall be repaired and test repeated until system passes tests at no additional cost to Owner.

B. Irrigation Audit Report with Certificate of Completion

1. Per the requirements of the California Model Water Efficient Landscape Ordinance, the Contractor shall perform an irrigation audit and provide a report with certificate of completion to the local agency that may include, but is not limited to: inspection, system tune-up, system test with distribution uniformity, reporting overspray or run off that causes overland flow, and preparation of an irrigation schedule. Irrigation audits shall be conducted by a CLIA Certified landscape Irrigation Auditor by the Irrigation Association. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

C. Adjustment of the System:

1. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways and buildings. Adjust the arc and radius as applicable.

2. Include as a part of the work any nozzle changes or arc adjustments necessary due to daytime windy conditions during grass establishment period. After grass has been established and watering can be performed during calm early morning or evening hours, make any required adjustments to nozzles and arcs.

3. Set all sprinkler heads perpendicular to finished grades unless otherwise noted on the drawings.
4. When the landscape sprinkler system is completed and before planting, perform a coverage test in the presence of the Owner’s Representative to determine if the water coverage for planting areas is adequate.

5. Test controllers individually in the presence of the Owner’s Representative and the Landscape Architect. Demonstrate that all control valves operate electronically. Provide vehicles and radio equipment as necessary to expedite this process.

6. Demonstrate to Owner’s Representative that irrigation scheduling programmed into controller is adequate for plant requirements without causing runoff, and that scheduling capacities of controller are utilized.

3.6 IRRIGATION SCHEDULING AND CONTROLLER PROGRAMMING

A. Per the requirements of the California Model Water Efficient Landscape Ordinance All irrigation schedules and programs shall be developed, managed and evaluated to utilize the minimum amount of water required to maintain plant health.

B. Irrigation controller Scheduling and Programming Parameters to be conducted by a CLCA Certified Irrigation manager and submitted to the local agency as part of the Certificate of Completion.

C. Parameters used to set the automatic controller shall be developed for each of the following:
   1. Plant establishment period
   2. Established landscape period
   3. Temporary irrigated area (if applicable)

D. Each irrigation schedule shall consider for each station all of the following that apply:
   1. Irrigation interval (days between irrigation)
   2. Irrigation run times (hours or minutes per irrigation event to avoid runoff)
   3. Number of cycle starts required for each irrigation event to avoid runoff
   4. Amount of applied water scheduled to be applied on a monthly basis
   5. Application rate setting
   6. Root depth setting
   7. Plant type setting
   8. Soil type
   9. Slope factor setting
   10. Shade factor setting
   11. Irrigation uniformity or efficiency setting
E. Total annual applied water shall be less than or equal to Maximum Applied Water Allowance (MAWA). Actual irrigation schedules shall be regulated by automatic irrigation controllers using current reference evapotranspiration data (CIMIS or soil moisture sensor data).

3.7 BACKFILL AND COMPACTING

A. General: After system is operating and required tests and reviews have been made, backfill excavations and trenches with clean soil, free of debris.

B. Backfill for All Trenches: Regardless of the type of pipe covered, compact to minimum 95% density under pavements and 85% under planted areas.

C. Finishing: Dress off areas to finish grades. Re-dress any areas which subsequently settle.

D. Owner's testing agency will test backfill compaction in areas under paving.

3.8 MAINTENANCE

A. The entire sprinkler irrigation system shall be under full automatic operation for a period of 2 days prior to any planting.

B. The Owner's Representative reserves the right to waive or shorten the operation period.

C. Maintain/repair system for full duration of plant maintenance period.

D. Pursuant to the requirements of the California Model Water Efficient Landscape Ordinance, the Owner is to provide a regular maintenance schedule with certificate of completion to the local water agency that may include, but is not limited to: routine inspection, adjustment and repair of the system and it's components, aerating and dethatching turf areas, replenishing mulch, fertilizing, pruning, weeding, removing and obstruction to emission devices. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance. Systems to be maintained to meet or exceed an average landscape irrigation efficiency of 0.71.

3.9 REVIEWS PRIOR TO ACCEPTANCE

A. Notify the Owner's Representative in advance for the following reviews, according to the time indicated:
   1. Supply line pressure test and control wire installation - 72 hours.
   2. Coverage and controller test - 72 hours.
   3. Final review - 7 days.

B. No reviews will commence without record drawings, without completing previously noted corrections, or without preparing the system for review.
3.10 FINAL REVIEW AND CLEANUP, per Section 01 77 00.

A. Operate each system in its entirety for the Owner's Representative at time of final review. Any items deemed not acceptable by the Owner's Representative shall be reworked to the complete satisfaction of the Owner's Representative.

B. Provide evidence to the Owner's Representative that the Owner has received all accessories and equipment as required before final review can occur.

C. Final acceptance and start of warranty period will occur no earlier than the end of the plant maintenance period.

D. For time of final review, Contractor shall arrange a meeting with the Owner's maintenance personnel to demonstrate the operation of the irrigation systems automatically in order to verify acceptance and to familiarize the maintenance personnel with the system and recommended programming.

END OF SECTION
NOTE: ALL STEEL TO RECEIVE HIGH PERFORMANCE COATING FINISH.

1/2" DIA. A307, TYP.

SEE DETAIL D2/AS-102

SEE D3/AS-102

3/16"

1'-0"

2 1/2"

3 1/2"

1'-6"

6" SEE PLAN S.O.G.

3/4" NON-SHRINK GROUT

MIN.

8" SEE STRUCTURAL GENERAL NOTES FOR RESIN AND TESTING REQ.

SEE C4/AS-102

3/4'' X 9'' SQ BASE PLATE CENTER ON POST

1 1/2" TYP.

1/2'' Ф WEEP HOLES

#10 STAINLESS STEEL SMS W/ NEOPRENE WASHERS AT 14" OC TOP AND BOTTOM TYP. FOR ENCLOSURE AND GATE.

PERFORATED CORRUGATED STEEL PANELS, ORIENTED VERTICALLY, 18 GA., MORIN BR7-35, 1/8" DIAMETER HOLES X 7/32" SPACING, 30% OPEN AREA, HIGH PERFORMANCE COATING FINISH. TYP. FOR ENCLOSURE AND GATE.

GA;LVANIZED STEEL HSS POSTS AND BEAMS, HIGH PERFORMANCE COATING FINISH, PT10. SECURED TO FRAMING WITH FRAME CLIPS, PROVIDE TOP AND BOTTOM CAPS.

HARDWARE (PROVIDER KIMBALL) - CANE BOLT WITH PADLOCK TO INTERIOR ON INACTIVE LEAF - LOCKSET - HEAVY DUTY CONTINUOUS STAINLESS STEEL GATE HINGES EACH LEAF.

TRANSFORMER ENCLOSURE - DETAILS

35003

04/26/18 ADDENDUM NO. 2

LOS MEDANOS COLLEGE

L-630 NEW BRENTWOOD CENTER

TRANSFORMER ENCLOSURE - DETAILS

AS-105

04/26/18 ADDENDUM NO. 2

5856 Doyle Street
Emeryville, CA 94608
Tel 510 899 6400 www.ratcliffarch.com

SEALS AND SIGNATURES

DSA APPROVAL 03/21/18

PERFORATED CORRUGATED PAINTED STEEL
MECHANICAL SCREEN. BR-7 PERFORATED STEEL
FANEL, 18 GA, 1/8" DIAMETER HOLES X 7/32"
SPACING, 30% OPEN AREA BY MORIN OR EQUAL.
HIGH PERFORMANCE COATING FINISH

WALL 4: 2' H. X 16' W. X 22 GA. FLAT PANEL PAN METAL
ROOFING PANELS, MECHANICALLY SEALED SIDE LAP

Reference Sheet #:
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<th>Color</th>
<th>Application</th>
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<td>HorseRadish 1086-1 per Specifications</td>
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**Addendum No. 2 4/26/18**

- See Area Annotated On Elevations and Plan
- At All Structural Supports, Metal Decking Roof and Gutters and At All Structural "C" and "L" Shapes At At
- All Exposed Interior / Exterior Acoustic / Structural Decking To Underside Of Spine Roof.
- Non-Acoustical Decking And At All Exposed Structural Decking To Underside Of Spine Roof.
- Lab Rooms 217, 218, 209 and 255 Only.

**True North**

**BRENTWOOD CENTER**

**Los Medanos College**

**L-630 NEW BRENTWOOD CENTER**

**Plan Number**

**Sheet Title**

**DSA Approval**

**Seals and Signatures**
### SCHEDULES

#### PROJECT NUMBER:

#### SHEET NUMBER:

#### SCALE:

#### SHEET TITLE:

**Key Plan**

5856 Doyle Street
Emeryville, CA 94608
Tel  510 899 6400
www.ratcliffarch.com

#### SEALS AND SIGNATURES

**DSA APPROVAL**

5/22/2017 1:10:23 PM

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**ISSUE SCHEDULE NO. DATE**

04/26/18 ADDENDUM NO.2

**FILE NO:**

**CHECKED BY:**

**DRAWN BY:**

**7-C1**
The Heating Hot Water System Control Diagram shows the flow of water through the system with various components such as pumps, valves, and temperature control elements. The system operates as follows:

1. **Start Sequence**: The start sequence begins by starting the lead hot water pump. After a time delay, the lead boiler isolation valve opens. When another time delay occurs, two respective boiler start/stop points turn on. After flow is proven, the boiler operations are normal.

2. **Boiler Alternation**: The heating hot water system consists of two boilers with two headered variable volume hot water pumps. Each boiler and pump is designated as full standby.

3. **System Flow**: The heating hot water system maintains a setpoint temperature of 140°F. The system is controlled with electric actuation and variable frequency drive. The pump is controlled via variable frequency drive.

4. **Bypass Valve**: The BAS controller shall operate the bypass valve to maintain a minimum flow rate of 30 GPM (adjustable) when one stage of the lead boiler is firing to maintain setpoint and above the minimum flow condition (25 GPM per boiler).

5. **Boiler Operation**: When the measured system flow is <70 GPM, the BAS controller shall disable one boiler and allow 5 minutes stage all 2 boilers firing in parallel to maintain setpoint.

6. **Flow Monitoring**: The BAS controller shall open an isolation valve and enable an additional boiler if the measured system flow is higher than 55 GPM (adjustable). The BAS system shall modulate the bypass valve to maintain a minimum flow rate of 30 GPM (adjustable) for boiler cooldown. The BAS controller shall close isolation valves if the flow drops below 40% in parallel pumping.

7. **Temperature Control**: The heating hot water supply temperature is initially set at 135°F (adjustable). The return temperature shall be set to use the lowest heating hot water temperature that satisfies all coil requirements. Evaluation of the lead, second, and third pumps is evaluated on a weekly basis. The pump with the least runtime is the lead pump. The pump with the most runtime is the lag pump. The remaining pump is the second pump.

8. **Alarm Monitoring**: Pump status and boiler alarms shall be monitored by BAS. Upon failure, an alarm shall be generated. Failed pumps are not allowed to start until the failed pump has been removed from the system. The failed pump shall be automatically restarted after the failed pump has been removed from the system.

9. **Temperature Control**: The heating hot water system is controlled by the BAS controller. The system operates as follows:

- **Temperature Setup**: The heating hot water system is controlled by the BAS controller. The system maintains a setpoint temperature of 140°F. The system is controlled with electric actuation and variable frequency drive. The pump is controlled via variable frequency drive.

- **Pump Monitoring**: The system monitors the pump status and boiler alarms. Upon failure, an alarm shall be generated. Failed pumps are not allowed to start until the failed pump has been removed from the system. The pump shall be automatically restarted after the failed pump has been removed from the system.

- **Flow Monitoring**: The system monitors the flow rate. When the lead pump reaches 80% of the maximum speed for more than a minute, the flow rate drops below 40% in parallel pumping. The second hot water pump is started. The third pump is the second pump. The remaining pump is the third pump.

- **Temperature Monitoring**: The system monitors the temperature. When the lead pump reaches 80% of the maximum speed for more than a minute, the flow rate drops below 40% in parallel pumping. The second hot water pump is started. The third pump is the second pump. The remaining pump is the third pump.

- **Alarm Monitoring**: Pump status and boiler alarms shall be monitored by BAS. Upon failure, an alarm shall be generated. Failed pumps are not allowed to start until the failed pump has been removed from the system. The failed pump shall be automatically restarted after the failed pump has been removed from the system.
SEQUENCE OF OPERATIONS

1. CHILLER KW
2. CHILLED WATER SUPPLY TEMPERATURE
3. CHILLED WATER RETURN TEMPERATURE
4. CHILLED WATER RETURN TEMPERATURE
5. CIRCUIT 2 - SATURATED REFRIGERANT TEMPERATURE
6. CIRCUIT 1 - REFRIGERANT PRESSURE (PSI)
7. CIRCUIT 2 - REFRIGERANT PRESSURE (PSI)
8. MAKEUP WATER PRESSURE
9. CIRCUIT 2 - SATURATED REFRIGERANT TEMPERATURE
10. CIRCUIT 2 - REFRIGERANT PRESSURE (PSI)
11. COMPRESSOR 1 RUNNING STATUS
12. COMPRESSOR 2 RUNNING STATUS
13. COMPRESSOR 2 RUNNING STATUS
14. COMPRESSOR 1 RUNNING STATUS
15. COMPRESSOR 2 RUNNING STATUS
16. COMPRESSOR 1 RUNNING STATUS
17. VFD COMPRESSOR FREQUENCY COMMAND
18. ALL ALARMS AVAILABLE FROM CHILLER CONTROL PANEL

EXTRACTED FROM THE CHILLER FACTORY CONTROLLER SHALL INCLUDE THE FOLLOWING:

- Modulate the bypass valve to maintain the minimum chilled water flow through the chiller (275 GPM, adjustable)
- By-pass control valve sequence
- The pressure drop-flow rate data from the chiller endor to implement this controls
- The controls sequence shall look up the corresponding flow rate based on the measure differential pressure across the chiller.
- The chilled water supply header and one of more zones' temperature setpoint is not met, then the BAS system shall lower the supply temperature by 1°F.
- The chilled water supply and return header.
- The BAS system shall issue an alarm.
- The BAS system shall start the chilled water system when there is a cooling demand from any of the air handling units and outside air is higher than 60°F.
- Upon a system start command is issued, the BAS system shall start the lead pump. When the two chilled water pumps shall operate as a one-operating-one standby configuration.
- If the lead pump fails to start, the BAS system shall start the standby pump and issue an alarm.
- The BAS system shall start the chilled water system when there is a cooling demand from any of the air handling units and outside air is higher than 60°F.
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**Sheet Notes:**
- Plumbing flows towards the Structural Beam Penetration.
- Coordination with piping down to underfloor trench. See 1/2"DCW, 1/2"SHW, 1"RW, 2"SV, 4"SS to Water Closet. Piping to underground.
- Addendum 02 2 04/26/18

Los Medanos College
New Brentwood Center

Los Medanos College

Engineers
5856 Doyle Street
Tel 510 899 6400

Division of State Architect

Issue Schedule No. Date

1. 01-116287
2. 10-C1
3. G-1
4. E-1
5. R-3
6. I-1
7. O-1
8. A-1
9. P-1
10. 4/23/2018 11:57:01 AM

1. 03/21/18 DSA Approval
**WATER METER SCHEDULE**

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**GAS SHUT-OFF VALVE BOX SCHEDULE**

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**EQUIPMENT TAG ON CENTER DRAWING LOCATION**

- CONDITION WITH DIVISION 26 FOR POWER.
- USE ONLY FITTINGS AS SHOWN IN PIPING DIAGRAM DETAILS.
- INSTALL PRIMARY SEWAGE RECEIVING SEWER IN ACCORDANCE WITH PERMITS.
- PROVIDE ACCESS PANELS IF NECESSARY.
- PROVIDE WATER HAMMER ARRESTORS AS SHOWN IN PIPING DIAGRAM DETAILS.
- INSTALL PLUMBING FIXTURES AND TRIM FROM ONE MANUFACTURER FOR UNIFORMITY OF INSTALLATION.
- INSTALL ELECTRIC TRAPS.
MINIMUM PRESSURE FOR GAS OUTLETS IS 7’W.C.

NOTE:
- NATURAL GAS EQUIPMENT: GAS FIRED WATER HEATER 250, 1300 CFH, Boiler 2800, 2-1/2” NG, 250 CFH.
- NATURAL GAS PIPING SEGMENT INFO
- WATER HEATER - GAS REGULATOR METER ASSEMBLY
- BOILER - GAS REGULATOR METER ASSEMBLY
- GAS REGULATOR METER ASSEMBLY

SYSTEM DESCRIPTION:
- TAG
- N→M 500 3050 3”
- O→N 500 3050 3”
- P→O 500 3050 3”
- Q→P 500 2800 2-1/2”
- D→C 500 3771 3”
- G→F 500 3771 3”
- M→L 500 3526 3”
- E→D 500 3771 3”
- B→A 500 3771 3”
- F→E 500 3771 3”
- K→J 500 3764 3”
- I→H 500 3771 3”
- J→I 500 3771 3”
- GAS FIRED WATER HEATER 250 CFH
- 1300 CFH, 1” NG, 500 CFH
- BOILER 2800 CFH
- 2-1/2” NG, 250 CFH
- 3/4” NG, 100 CFH
- 1/4” NG, 112 CFH
- 1/2” NG, 231 CFH
- 1” NG, 56 CFH
- 2” NG, 476 CFH
- 1½” NG, 28 CFH
- 3/4” NG, 14 CFH
- 1¼” NG, 98 CFH
- 1/2” NG, 112 CFH
- 1/4” NG, 126 CFH
- 5” NG, 70 CFH

Piping segments as shown below calculated at most remote outlet Q, as per CPC 1216.2.

Design Conditions
- System Description:
- Equipment Info
- Piping Underwater.
- Natural Gas Transitions From Black Steel to Polyethylene Underwater.
- Piping segments as shown below calculated at most remote outlet Q, as per CPC 1216.2.

Note:
- Natural gas transitions from black steel to polyethylene underwater.
- Piping segments as shown below calculated at most remote outlet Q, as per CPC 1216.2.

Addendum 02 20/04/18

San Francisco, CA 94109
1133 Post Street
Tel 510 899 6400
www.ratcliffarch.com
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