Facilities Division

Klystron Gallery

Sector 20 FACET Laser Room

SLAC-I-383-100-03-R000

Prepared and Approved by Victor Longa, Project Manager
date 6/19/12

Reviewed and Approved by KS Wong, Electrical Engineering Group Leader
date 6/19/12

Reviewed and Approved by Harry Shin, Mechanical Engineer
date 6/19/12

Reviewed and Approved by Christine Clarke, ARD Test Facilities(Customer)
date 6/20/12

Reviewed and Approved by Ernie Gomes, Building Inspection Office
date

SLAC National Accelerator Laboratory
2575 Sand Hill Road
Menlo Park, CA 94025
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>PAGE(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>010000</td>
<td>General Requirements</td>
<td>1 to 10</td>
</tr>
<tr>
<td>011100</td>
<td>Hold Points</td>
<td>1 of 1</td>
</tr>
<tr>
<td>211300</td>
<td>Fire Suppression Sprinkler Systems</td>
<td>1 to 7</td>
</tr>
<tr>
<td>230000</td>
<td>Basic HVAC Requirements</td>
<td>1 to 12</td>
</tr>
<tr>
<td>230593</td>
<td>Testing, Adjusting &amp; Balancing</td>
<td>1 to 13</td>
</tr>
<tr>
<td>233100</td>
<td>Ductwork</td>
<td>1 to 7</td>
</tr>
<tr>
<td>260000</td>
<td>Basic Electrical Requirements</td>
<td>1 to 6</td>
</tr>
<tr>
<td>260519</td>
<td>Wires, Cables &amp; Connectors</td>
<td>1 to 3</td>
</tr>
<tr>
<td>260533</td>
<td>Raceways</td>
<td>1 to 5</td>
</tr>
<tr>
<td>260534</td>
<td>Boxes</td>
<td>1 to 3</td>
</tr>
<tr>
<td>260553</td>
<td>Electrical Identification</td>
<td>1 to 3</td>
</tr>
<tr>
<td>262726</td>
<td>Wiring Devices</td>
<td>1 to 3</td>
</tr>
</tbody>
</table>

ATTACHMENTS

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Drawing Number</th>
<th>Drawing/Document Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ID-383-700-21-C0</td>
<td>FACET Laser Room General Title Sheet</td>
</tr>
<tr>
<td>2</td>
<td>ID-383-100-03-C0</td>
<td>FACET Laser Room Architectural Plan, Section and Details (2-sheets)</td>
</tr>
<tr>
<td>3</td>
<td>ID-383-700-22-C0</td>
<td>FACET Laser Room Electrical - Power Demo/New Work Plan</td>
</tr>
<tr>
<td>4</td>
<td>ID-383-700-23-C0</td>
<td>FACET Laser Room Electrical - Telephone, Data &amp; Fire Alarm Relocate/New Work Plan</td>
</tr>
<tr>
<td>5</td>
<td>ID-383-700-24-C0</td>
<td>FACET Laser Room Electrical – Lighting Demo/New Work Plan</td>
</tr>
<tr>
<td>6</td>
<td>ID-383-600-01-C0</td>
<td>FACET Laser Room Mechanical – HVAC Demo/New Work Plan</td>
</tr>
</tbody>
</table>
SECTION 010000 – GENERAL REQUIREMENTS

PART 1 - GENERAL

The following specification outlines the requirements for the S-20 FACET Laser Rm. Reconfiguration

1.1 LOCATION:

Perform the work outlined in this specification at the SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, San Mateo County, California, at the specified location. The job site is Bldg.002-C, Sector 20, rooms 20-1 & 20-5.

1.2 SCOPE OF WORK:

The Subcontractor shall furnish all labor, materials, tools, equipment, and incidentals necessary to perform the work indicated in these specifications.

The purpose of this specification is to describe the intended results of the work, identify certain reference standards, and provide certain technical details. Where standards are not specified, the Subcontractor shall perform the work in accordance with the best general construction practices and industry standards, codes, and provide all new materials and workmanship of the first quality. Where the specifications do not provide complete details, the Subcontractor shall provide a submittal to the University for prior approval, showing the details of the planned method for meeting the Subcontract requirements. The term "contractor" as used in the Specifications and Drawings shall mean "Subcontractor". The term "should" as used in the Drawings shall mean "shall". The term "Provide" as used in the specifications and drawings shall mean "Furnish and Install".

The Subcontractor shall verify all dimensions, locations and quantities in the field prior to providing price proposal and construction, and shall furnish all construction surveys and tests required for correct location and installation of all work.

The Subcontractor is required to comply with all articles and provisions of the General Terms and Conditions and Request for Proposal (RFP) included in this package.

The Subcontractor is required to provide employees who are trained and experienced in performing the work required under the conditions existing for this project. A Supervisor having the authority to act as a representative for the subcontractor shall be on the job during the course of work being performed. The Subcontractor shall provide personal protective equipment for all Subcontractor personnel onsite, including steel toed footwear, hard hats, safety glasses, work gloves and reflective vests.

1.3 DESCRIPTION:

A. The work includes but is not limited to the following tasks:

1. Dust must be mitigated during construction to keep both the work area clean and to prevent migration into the adjacent existing LCLS Laser room.

2. Existing Laser table in room 20-1 will remain, all other user equipment will be removed by SLAC prior to start of construction. Subcontractor to provide protection from damage for the existing Laser table thru-out the construction period.
3. Install ceiling height wall, finish & paint, door and hardware to match existing in room 20-5 per drawings.

4. Provide 8'x 8' cased opening between rooms 20-1 & 20-5 per drawings and details. Drywall, texture, paint and cable tray to be replaced.

5. Provide soffit around water piping & walls from floor to soffit to be used as return air plenums, follow details on design drawings.

6. Install a 10' high T-bar 2'x 4' acoustical ceiling in room 20-1.

7. Relocate Vesda Air sampling enclosure including re-routing of sample tubing & wiring from FACP. Modify/relocate air sampling in room 20-1 to new T-bar ceiling height.

8. Relocate/install fire sprinklers at new T-bar ceiling height, per drawings. Provide shop drawings per NFPA 13 for modifications made to sprinkler systems in the affected area.

9. Make modifications to the HVAC system serving rooms 20-1 & 20-5. See related sections and drawings.

10. Furnish & install conduit, wiring and all hardware for 6 – Fluorescent 2'x 4' 2-lamp fixtures w/ parabolic reflectors in room 20-1 per drawings. Provide circuit, conduit, boxes and wiring at new wall location for A/B switching throughout rooms 20-1 & 20-5.

11. Retrofit new & existing fixtures at rooms 20-1 & 20-5 w/ LED lamps furnished by SLAC.

12. Install conduit, wiring, boxes and all hardware for 1 – 30A 208V 3ph laser circuit. Install L14-30R receptacle, placement on drawing is approximate, coordinate exact placement w/ FCM per customer equipment orientation.

13. Remove existing 60A 208V 3ph receptacle, conduit & wiring and re-work into new 6"x 6"x 4" enclosure above ceiling. Replace circuit breaker with 30A. Install conduit, wiring, boxes and all hardware for L21-30R receptacle, placement on drawing is approximate, coordinate exact placement w/ FCM per customer equipment orientation.

14. Install conduit, wiring and all hardware for 2 – duplex receptacles for LSS system at entry of and in room 20-5.

15. Remove abandoned water piping in room 20-1, bins will be provided by SLAC to salvage/recycle.

16. Install exit only/crash hardware and fill lite panel at exterior door. Install exit only/crash hardware for interior double doors per drawings.

17. Remove 1 – interior door & hardware between rooms 20-1 & 20-5, leave jam in place.

B. Deliverables:
   a. Submit Safety Documents to the University for Approval within 10 days after award.
   b. Provide Construction Schedule in MS project and PDF format unless otherwise noted.
   c. Clean the worksite and perform a Final Inspection report.
d. Provide electronic and hard copies of final marked up as-built construction drawings in Adobe PDF and AutoCAD format. Prepare drawings and follow requirements of “Drawing deliverables for A&E Firms & Subcontractors”, document # DS-016-410-18. A CD containing a soft copy of “Drawing deliverables for A&E Firms & Subcontractors”, document # DS-016-410-18 and SLAC logo border will be provided by the University. Fill out the drawing index with the as-built drawing information.

e. Fire Alarm sub-contractor to provide stamped engineered drawings to support modifications made.

C. Submittals

1. Provide submittals to the University for approval as specified in other sections of these specifications

1.4 SPECIAL REQUIREMENTS AND CONDITIONS:

SLAC requires additional documentation of your company safety program and specific documents depending on the phase and hazards associated with a given project. These documents shall include, but are not limited to:

A. All workers shall complete SLAC safety training course 375 (approximately one hour in duration) and obtain a SLAC badge prior to working on site.

B. Company Illness Injury Prevention Plan (one for each contractor and subcontractor).

C. Company Lock Out Tag Out program (LOTO) – for each subcontractor

D. Site Specific Safety Plan (SSSP) (covers all contractor/subcontractors for entire project)

E. Job Safety Analysis (JSA) (daily)

Various SLAC specific plans and permits including, but not limited to excavation, hot (burning/brazing) work, hoisting and rigging, excavations and penetrations (provided by SLAC), fall protection, confined space, demolition etc. may be required if applicable. You are responsible for supplying these and other documents as defined in the other subcontract documents and appendices including General Terms and Conditions, Request for Proposal (RFP), and SLAC ES&H Chapter 42 etc.

Handling of construction/demolition waste:

A. Hazardous wastes, Class 2 wastes, Universal wastes: Subcontractor will segregate wastes and place them in appropriate labeled bins provided by SLAC Waste Management (WM). Any and all hazardous waste, including sludge removed from sewer lines, and other Class II regulated wastes generated by this project will be disposed of by SLAC’s Waste Management Department. Subcontractor shall coordinate with FCM/UTR for procedures.

B. Recyclable waste: Subcontractor shall provide bins and recycle them. SLAC requires that non-hazardous construction waste such as cardboard, wood, and scrap metal be recycled or reused instead of disposed as trash. Subcontractor shall prepare a list before the end of the project which reports to SLAC the types and volumes of recycled material from the project.

C. Clean, non contaminated waste: Subcontractor shall provide bins and dispose the waste.

1.5 PERFORMANCE PERIOD & SCHEDULE AFTER AWARD:

A. Sub-contractor to coordinate with FCM & Project manager key dates for utility tie-ins. Notify the University at least 72 hours before any utility shutdown or tie-in.

B. Sub-contractor and all sub-tiers to complete all construction by September 7, 2012.
1.6 ATTACHMENTS:
The Subcontractor shall comply with the documents and/or SLAC Drawings as listed under "Attachments" in the Table of Contents.

1.7 REFERENCED STANDARDS:

All work performed shall meet or exceed requirements of the codes, standards and regulations listed below. All codes, standards and referenced specifications indicated shall mean latest edition, including supplement when such exists, unless otherwise stated. Refer to individual sections for specific reference standards. Additional standards are stated in the "General Terms and Conditions" and "Request For Proposal" (RFP), which in addition to these specifications are part of your subcontract documents.

A. California Building Code (CBC), 2010 edition
B. California Plumbing Code (CBC), 2010 edition
C. California Mechanical Code (CMC), 2010 edition
D. California Fire Code (CFC), 2010 edition
E. SMACNA, HVAC Duct Construction Standards
F. Americans with Disabilities Act (ADA)
G. ASHRAE, Standards and Handbooks
H. National Fire Protection Association (NFPA) Standards
J. Institute of Electrical and Electronic Engineers (IEEE) Standards
K. Underwriters Laboratories (UL) listing and labeling of equipment
L. American National Standards Institute (ANSI)
M. American Welding Society, (AWS) Standards
N. American Society of Mechanical Engineers (ASME)
O. American Society of Testing and Materials (ASTM)
P. American Concrete Institute (ACI) Standards
Q. American Institute of Steel Construction (AISC)
R. Steel Structures Painting Council (SSPC)
S. California Code of Regulations, Title 8, Cal OSHA
V. Manufacturer's material and equipment installation and operating instructions and recommendations.
W. Standards of other publicly recognized standards organizations.
X. Codes and regulations of all agencies having jurisdiction.
1.8 EXCLUSIONS, UNIVERSITY FURNISHED MATERIAL, EQUIPMENT AND SERVICES:

A. University Furnished Materials:
   1. Laser power supplies shall be installed by SLAC prior to Electrical connection by the subcontractor.
   2. LED lamps for 2' x 4' fixtures in rooms 20-1 & 20-5 furnished by SLAC.

B. University Furnished Services:
   1. SLAC Facilities Electricians shall perform all switching, LOTO(lock-out/tag-out) and ZVV(zero voltage verification) prior to releasing the equipment to the sub-contractor Electricians.
   2. SLAC Facilities HVAC Technicians shall shut down, secure, LOTO(lock-out/tag-out) and provide ZEV(zero energy verification) prior to releasing the equipment to the sub-contractor.
   3. Arc Flash labeling will be provided and installed by SLAC prior to the energization of any new or reconfigured equipment.

1.9 RELATED SECTIONS:
   A. Section 211300 “Fire Suppression Sprinkler Systems”
   B. Section 230000 “Basic HVAC Requirements”
   C. Section 230593 “Testing, Adjusting & Balancing”
   D. Section 233100 “Ductwork”
   E. Section 260000 “Basic Electrical Requirements”
   F. Section 260519 “Wires, Cables & Connectors”
   G. Section 260533 “Raceways”
   H. Section 260534 “Boxes”
   I. Section 260553 “Electrical Identification”
   J. Section 262726 “Wiring Devices”

1.10 INTENT AND ARRANGEMENT OF DOCUMENTS

A. It is intended that these specifications and drawings include everything necessary to perform the entire work properly. Every item necessarily required may not be specifically mentioned or shown. All systems and equipment shall be complete and operable unless expressly stated otherwise.

B. Titles and headings to divisions, sections and paragraphs in these Subcontract documents are introduced for convenience and shall not be taken as a correct or complete segregation of the several units of materials and labor. No responsibility either direct or implied is assumed by the University or its designated Representative for omissions or duplications by Contractor or its Subcontractors, due to real or alleged error in arrangement of matter in the Subcontract documents.

C. The terms of the Subcontract, General Provisions, and General Requirements apply to each section of these specifications as fully as if repeated within that division.

D. Items listed under each division or section of the specifications is not necessarily all inclusive. Contractor shall be responsible for performance and completion of the work in accordance with the scope of work detailed in Division 01 Section – Summary – Design Build Projects and the Subcontract documents.

E. Portions of these specifications are of the abbreviated, simplified type and may include incomplete sentences.
   1. Omissions of words or phrases such as "Subcontractor shall," "in conformity with," "shall be," "as noted on the drawings," "in accordance with details," "a," "the" and "all" are intentional.
Omitted words or phrases shall be supplied by inference in the same manner as they are when a "note" occurs on the drawings.
2. Such terms as "approved," "approved equal," "as directed," "as required," "as permitted," "acceptable," "satisfactory" mean by or to the University.

1.11 DEFINITION OF TERMS

A. General:
   1. The definition of terms used in the Subcontract, the drawings, and specifications are as follows and shall apply throughout.

B. University or The University:
   1. See the Terms and Conditions of the Subcontract.

C. SLAC:
   1. See the Terms and Conditions of the Subcontract.

D. "Subcontractor":
   1. The party responsible for the execution of the construction, Subcontract, or any portion thereof, that has been awarded by the University. This term shall include the general or any and all prime subcontractor(s), all lower tier subcontractors, and suppliers. The term "subcontractor" may refer to any lower tier subcontractor concerned with the section or division of the subcontract specifications in which the term is used. This in no way relieves the "Subcontractor" from sole responsibility for completing the entire work as required by the Subcontract.

E. University Representatives:
   1. The University Representatives titles and responsibilities, as well as the abbreviations used in the Subcontract Documents, are as follows:
      a. PM - Project Manager: SLAC’s representative, responsible for project management.
      b. SA - Subcontract Administrator: SLAC’s representative responsible for administering all business matters of a contractual nature pertaining to construction work. The Subcontract Administrator participates in change order negotiations and is SLAC’s representative authorized to affect binding formal changes to the Subcontract as required.
      c. CM - Construction Manager: SLAC’s representative, during the construction phase, for technical oversight of the execution of the construction Subcontract.
      d. UTR/FCM - University Technical Representative/Field Construction Manager: SLAC’s representative for matters relating to construction field support. Point of Contact for SLAC Work Planning and Control.
      e. PE - Project Engineer: SLAC’s representative for technical issues relating to design and construction.
      f. By Others: The work indicated by this term means that the work is not included in the Subcontract. The acronym NIC (not in contract) means "by others".

F. "Furnish":
   1. See the Terms and Conditions of the Subcontract.

G. "Install":
   1. See the Terms and Conditions of the Subcontract.

H. "Provide":
   1. See the Terms and Conditions of the Subcontract.
1.12 RESPONSIBILITIES

A. Construction Manager Responsibilities:

1. Coordinate the construction decisions required of the University relating to the drawings, specifications, and other construction information furnished to Subcontractor pursuant to the Subcontract or necessary for successful performance of the work;
2. Monitor Subcontractor's safety program for compliance with University requirements and other applicable codes and regulations, and responsibility for general surveillance over the implementation of security procedures;
3. Participate in the initiation and preparation of technical changes in the applicable drawings, specifications, and other construction data;
4. Quality assurance oversight of work in progress;
5. Identify and oversee the required work by Subcontractor to correct defects discovered in partially or fully completed construction work;
6. Review for University approval, Subcontractor's invoices for payment;
7. Coordinate for the University in the areas designated herein. Subcontractor shall refer questions, submittals, and like items, in these designated areas to the Construction Manager. Neither the rights of general supervision, direction, inspection, review, comment, or approval conferred on the Construction Manager, nor its exercise of these rights, shall relieve Subcontractor from the obligations set forth in the Subcontract documents except University's written acceptance of specific portions of work containing patent defects if such defects have been called to the Construction Manager's attention, in writing by Subcontractor, before the Construction Manager's review and approval;
8. Provide coordination of multiple prime Subcontracts, including scheduling and interface between other Subcontractors.
9. Conduct weekly construction meetings, coordination meetings, and pre-installation meetings as defined in Division 01 Section "Project Management and Coordination".

B. Limits of CM Authority:

1. The Construction Manager will not issue, and Subcontractor shall not comply with, any technical instructions or directions, either oral or in writing, which would:
   a. Constitute an assignment of work outside the general scope of the work covered by this Subcontract; or
   b. Increase or decrease the price for performance of the work or the time required for performance of the work covered by this Subcontract; or
   c. Change any express term or condition of the Subcontract; or
   d. Unreasonably interfere with Subcontractor's ability to perform and complete the work as required under the Subcontract. The term "unreasonably" shall be quantifiable by either time or cost.

C. University Technical Representative/Field Construction Manager Responsibilities:

1. Provide oversight to ensure the safety, environmental, health, safeguard, and security requirements specified in the Subcontract are met by construction Subcontractors.
2. Coordinate with Subcontractor to schedule inspections required for construction work in the scope of the Subcontract.
3. Assist Subcontractor with permits required by SLAC for construction work in the scope of the Subcontract.
5. Coordinate with SLAC Waste Management.
6. Coordinate and maintain the SLAC Work Planning and Control documents.

D. Project Manager Responsibilities:

1. See the Terms and Conditions of the Subcontract.
E. Project Engineer Responsibilities:
   1. Provide oversight and guidance for technical matters during design, construction, testing and startup of the facilities.
   2. Provide to Subcontractor, through the CM, interpretations and clarifications to the applicable drawings and specifications and other construction data and reconciling discrepancies in the aforementioned documents and data as may be required.
   3. Issue written technical instructions within the scope of work stated in the Subcontract.
   4. Review for University approval, vendor submittals and shop drawings.

1.13 INFORMATION TRANSMITTAL

A. Submittals to the Construction Manager: Submit the information and documents described in the following subparagraphs:
   1. Progress Schedule: As required in Division 01 Section "Construction Progress Documentation."
   2. Project Record Documents: As required in Division 01 Section "Project Record Documents", one complete marked-up set of drawings and specifications fully illustrating all revisions made by all the crafts in the course of the work, due prior to final acceptance inspection. Additionally, make available to the CM and the University updated (as-built) drawings and specifications to be reviewed in conjunction with the monthly progress-payment. Project record drawings and specifications shall include all field changes, adjustments, variances, requests-for-information (RFIs), change orders, substitutions and deletions whether covered by change order or not, and shall be updated on a daily basis. Underground utility installations shall be shown on the marked-up drawings precisely as constructed. Keep as-built drawings on a separate set of drawings with revisions marked in red.
   3. Quality Program: Submit a quality assurance plan customized to this office building project within 30 working days from the award of Subcontract.
   4. Hazardous Material Inventory Sheets: Seven copies of completed hazardous material inventory sheets.
   5. Cost Breakdown/Schedule of Values: A preliminary segregation of the Subcontract price itemizing the estimated cost of each class of work that corresponds to the phases of items indicated in the Contractor's baseline schedule, by work breakdown structure (WBS), due at Notice to Proceed. Each item shall include a prorated amount for profit, insurance, and overhead expense and the total of the items shall equal the Subcontract price. Bond expense shall not be prorated but shall be shown as a separate item. This segregation, when approved by the University, shall become the basis for determining progress payments when progress payments are required. Submit final schedule of values within 30 calendar days of Notice to Proceed. The first progress payment will not be made until the schedule of values has been submitted. The progress schedule will be cost loaded to support and equal the cost breakdown schedule of values. Provide a chart of the proposed spending profile (including items such as long lead procurements) with over lay of the phased funding profile.

B. Submittals to the Subcontract Administrator: Submit within 10 calendar days after the notice of award, a list of Contractor’s Subcontractors. Include Subcontractors’ telephone numbers and addresses.

1.14 ACCURACY OF DATA

A. The data in these specifications and on the drawings are as exact as could be secured, but their absolute accuracy cannot be guaranteed. The drawings and specifications are for the assistance and guidance of Subcontractor and exact locations, distances, levels, and like items will be governed by the work.
B. Take these data with the understanding that the drawings and specifications may be supplemented by more detailed specifications and drawings intended to aid construction without changing the scope or cost of the work. Conform to them without additional cost to the University.
1.15 CONSTRUCTION LIMITS

   A. The limits of work under this Subcontract are shown on the drawings. Confine construction operations to the area shown in Subcontract drawings.

1.16 MODIFICATIONS OR CONNECTIONS TO EXISTING UTILITIES

   A. If modifications or connections to the existing utilities (e.g., electric power, water, gas, communications and air) require an interruption of services, give the Construction Manager written notice 14 calendar days prior to the desired modification or connection or as defined in the specifications.

1.17 SITE STAFFING, SUPERVISION, AND OVERTIME

   A. As a minimum, subcontractor shall provide staff positions for the following:

      1. Construction superintendent (full time on site)
      2. Project manager (full time on site)
      3. Quality control manager (part time on site, dedicated only to QC)
      4. Safety officer, OSHA 30-hour Construction Safety training required.

          a. For project staffing levels 30 or greater (including subcontractor and sub-subcontractors), full-time on site, dedicated only to safety.

          b. For project staffing levels fewer than 30 (including subcontractor and sub-subcontractors), must have a person at least 50% of whose work a SLAC is dedicated to safety management. This may be a collateral duty assignment; that is, be assigned to another member of the work group other than the superintendent.

   B. The quality control manager can be a corporate resource that oversee work on this project on a part-time basis and can delegate full-time responsibility to other individuals.

   C. Submit to the Project Manager or his designated person, the name of the person(s) designated as construction superintendent, project manager, QC manager, and safety officer. Provide a construction superintendent and a project manager with adequate experience working on projects similar to that described in these Specifications. Provide a QC manager and safety officer with adequate experience working on projects similar to that described in these Specifications. The University will have the final determination of the adequacy of the proposed personnel's experience. The construction superintendent shall be in residence at the jobsite at all times, including overtime hours and shift work hours, when work is being performed by Subcontractor or sub-Subcontractors. If Subcontractor's superintendent leaves the jobsite while work is being performed, the University will stop all work. Any costs that Subcontractor might incur due to said stoppage will be solely at Subcontractor's expense.

   D. Submit to the University for approval, written resume(s) for its construction superintendent, project manager, QC manager, and safety officer. Resume(s) shall document the years of experience as referenced above. The resume(s) shall include, for each project, the following minimum information:

      1. Project name, start date, and finish date
      2. Project owner's name
      3. Contact name and phone number
      4. Summary of project's scope of work

   E. Requests for nonstandard work hours shall be submitted to the Construction Manager 48 hours in advance.

1.18 SALVABLE AND EXCESS MATERIALS

   A. Salvable material dismantled from existing work shall not be used in new construction unless specifically indicated otherwise in the drawings or specifications.
B. All materials noted to be dismantled and reinstalled shall be dismantled and stored in such a manner to prevent damage. Subcontractor is responsible for the condition of these materials until they are reinstalled and accepted by the University.

C. All materials noted to be dismantled, salvaged, and to remain the property of the University shall be stored in such a manner as to prevent damage. Subcontractor is responsible for the condition of those materials until accepted by the University.

D. Recycle/dispose of non-hazardous recyclable materials and wastes per the Terms and Conditions of the Subcontract and requirements of this specification.

1.19 EMERGENCY REPAIRS
A. The University reserves the right to make emergency repairs as required to keep equipment in operation without voiding Subcontractor's guarantee or relieving Subcontractor of its responsibilities.

1.20 UNIVERSITY'S PARTIAL OCCUPANCY OR USE
A. The University reserves the right to occupy any completed or partially completed portion of the work provided that the University and Subcontractor have accepted, in writing, the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, utilities, damage to the work, insurance and the period for correction of the work and commencement of warranties required by the Subcontract documents for such portions of the work partially used or occupied by the University. In the event Subcontractor and the University are unable to agree upon the matters set forth above, the University may nevertheless use or occupy any completed or partially completed portion of the work, with the responsibility for such matters subject to resolution in accordance with the Subcontract documents. Immediately prior to such partial occupancy or use of the work, or portions thereof, the University, the Construction Manager, and Subcontractor shall jointly inspect the portions of the work to be occupied or to be used to determine and record the condition of the work.

1.21 FINAL ACCEPTANCE
A. Notice that the work is ready for final inspection and acceptance shall consist of a written notice issued to the Construction Manager by Subcontractor stating that Subcontractor has carefully inspected all portions of the work, has reviewed in detail the drawings and specifications and, that to the best of Subcontractor's knowledge, all conditions of the Subcontract documents have been fulfilled.

B. Upon receipt of this notice, the Subcontract Administrator, the Project Manager, the Project Engineer, the Construction Manager, the SLAC Building Official and Subcontractor shall make a joint inspection of the work. After deficiencies, if any, have been corrected or accounted for, the Notice of Completion and Acceptance will be issued and recorded by the University.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION NOT USED

END OF SECTION 010000
SECTION 01111 -- HOLD POINTS

1.01 HOLD POINTS:

Prior to commencement of the following activities, approval is required as indicated:

a) Review & approval of Work Plan & Schedule.
b) Review & approval of Material Submittals.
c) A Penetration permit is required for drilling or cutting holes in floors, walls or ceilings. Coordinate obtaining the permit with the FCM.
d) Review & approval of LOTO/CoHE plan prior to all Electrical, HVAC & Fire Protection work.
e) All Electrical Tie-ins will be coordinated with the FCM and per the approved schedule. Subcontractor to notify the University at least 72 hours before any utility shutdown or tie-in.
f) Start-up, Testing & Balancing of the HVAC system will be coordinated with the FCM and per the approved schedule.

END OF SECTION 01111
SECTION 211300 – FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:
1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Where items from the referenced Codes and Standards are repeated in this Specification, it is intended to call attention to them. It is not intended that other parts of the referenced Codes and Standards shall be assumed to be omitted if not repeated in this Specification.

C. Include all labor, material, equipment and service necessary for, and reasonably incidental to the design, fabrication, and installation of the complete automatic fire sprinkler systems.

D. It is the intent of these specifications to describe the complete wet pipe fire sprinkler systems. The Subcontractor is responsible for carefully and critically reviewing the contract plans, specifications, and site conditions to the extent and as far as practicable. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to SLAC for clarification.

E. In general, work shall include, but not be limited to:
1. Modifications to overhead automatic fire sprinkler systems for the new FACET laser room in accordance with NFPA 13, national design standards, applicable Codes, and these specifications.
2. Installation of flexible connections and seismic bracing.
3. Connection(s) to the building’s Class I, “Manual Wet”, Combination standpipe system.
4. Systems and device testing.
5. All necessary permits and/or fees.

F. The overhead automatic fire sprinkler systems shall be “zoned” by floor, with individual fire sprinkler floor control assemblies provided at each floor level with associated supervised system control valve, waterflow switch, pressure gauge, and drain/test valve assembly with discharge to a fire sprinkler system drain riser (minimum 2-inch diameter).

G. Fire sprinklers in finished ceiling areas shall be located in an aesthetically pleasing manner in order to coordinate with, and to the extent practicable, align with other ceiling fixture elements (e.g. lights, HVAC equipment, speakers, fire alarm devices, etc.). Where sprinklers are located in ceiling tiles, they shall be located in the “center-of-tile” unless otherwise specifically approved by the SLAC Representative. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, fire alarm, speakers, and office partition assemblies.

H. The Subcontractor shall be responsible for establishing and implementing all safety programs and procedures for this project and shall comply with all Federal, State and Local Safety and Health Regulations.
1.2 QUALITY ASSURANCE

A. Equipment: All equipment shall be Approved by Factory Mutual and/or Listed by Underwriters' Laboratories for fire protection service.

B. Subcontractor Qualification: The Subcontractor shall be a California Licensed Fire Protection Contractor (C-16) experienced in the installation of similar automatic fire protection systems.

1.3 REFERENCED STANDARDS

A. General:
   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
   3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

B. System, equipment, installation, and materials and methods used shall comply with the following:
   1. The requirements of the SLAC National Accelerator Laboratory.
   3. Manufacturer's recommendations and guidelines.

1.4 SUBMITTALS

A. Submit the following for approval in accordance with the General Requirements, Division 1:
   1. Working Plans as described in NFPA 13, shall be submitted within 15 days after the award of the contract. Installation shall not begin until approval has been received.
   2. Shop Drawings: Submit seven prints of each shop drawing. Minimum allowable sheet size is 22" x 24".
   3. Product Data: Within 15 days after the award of the contract, submit for approval seven copies of manufacturer's literature, wiring diagrams, etc., for each piece of equipment used in the system. If the manufacturer's catalog sheets show more than one item, the items proposed for use shall be identified.
   4. As-Built Drawings: Corrected and approved Working Plans shall be submitted in reproducible format (Xerox velum or approved equal) to the SLAC Representative prior to final acceptance of the installation.

1.5 WARRANTY

A. Except as otherwise expressly provided in the Subcontract Documents, and excepting only items of routine maintenance, ordinary wear and tear and unusual abuse or neglect, Subcontractor guarantees all work executed by him and all supplies, materials and devices of whatsoever nature incorporated in, or attached to the work, or otherwise delivered to the SLAC Representative as part of the work pursuant to the Subcontract, to be absolutely free of all
defects of workmanship and materials for a period of one year after final acceptance of the entire work by the SLAC Representative.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment furnished by the Subcontractor shall be new, first grade standard, current products of a manufacturer regularly engaged in the production of such materials and equipment. Where two or more pieces of equipment performing the same function are required, they shall be the product of one manufacturer and exact duplicates.

B. Acceptable Manufacturers
   1. Products described below and identified by product name, model number, or other manufacturer designation, are Basis of Design Products. Basis of Design Products establish the standards of type, function, dimension, in-service performance, physical properties, appearance, warranty, cost, and other characteristics required by the Project. The Project’s design is based on the Basis-of-Design Products specified.
   2. Subject to the requirements of Division 01 “General Requirements”, products of manufacturers not listed may be proposed for substitution, provided they are comparable to the products specified.
      a. If “No known equal” is indicated next to the product name, provide only products of listed manufacturers.
      b. The burden of proof of equality of proposed products is on the Subcontractor.

2.2 PIPING, FITTINGS, AND SPECIALTIES

A. New piping shall be designed for 175 PSI working pressure, conforming to ASTM specifications, and have the manufacturer’s name or brand along with the pipe applicable ASTM standard marked on each length of pipe.

B. Piping 2-inch and smaller shall be Schedule 40 black steel pipe. Pipe shall be manufactured in accordance with specifications ASTM A 135 and A 53.

C. Piping 2-1/2" and larger shall be Schedule 10 black steel pipe manufactured in accordance with specification ASTM A 135.

D. All fire protection system piping shall be provided with factory-applied antimicrobial coatings to inhibit Microbiologically-Influenced Corrosion (MIC). Allied Tube and Conduit "ABF II", Wheatland Tube Company "MIC Shield", or equal.

E. Other thin-walled piping materials (such as Schedule 5, XL and BLT threadable thinwalls, etc.) will not be permitted.

F. New Schedule 40 black steel pipe shall be joined by screwed joints in accordance with specification ANSI B 1.20.1 - 1983 (ANSI/ASME B 2.1), by welded joints in accordance with specification ANSI/ASME B 31.1, Chap. 5, or by UL - listed mechanical grooved couplings. Grooves may be rolled or cut and they shall be dimensionally compatible with the couplings.
G. Schedule 10 black steel pipe shall be joined by welded joints in accordance with specification ANSI/ASME B 31.1, Chap. 5, or by UL-listed mechanical grooved couplings. Grooves shall be rolled and shall be dimensionally compatible with the couplings.

H. Sprinkler piping and fittings exposed to weather, used in a corrosive atmosphere, or as noted on drawings shall be galvanized.

I. New screwed fittings shall be ductile or malleable iron, 150 lb. class, black, and in accordance with ANSI B 16.3. Screwed joints shall be made up with approved Teflon joint compound or tape.

J. Flanged fittings shall be cast iron, short body, Class 125, black, and in accordance with ANSI B 16.1. Gaskets shall be full-face of 1/8-in. minimum thickness red sheet rubber. Flange bolts shall be hexagon head machine bolts with heavy semi-finished hexagon head nuts, cadmium plated, having dimensions in accordance with ANSI B 18.2.

K. Welded fittings in accordance with Chapter 6 of NFPA 13 – 2010 shall be steel, standard weights, black, and in accordance with ANSI B 16.9, ANSI B 16.25, ASTM A 234, ANSI B 16.5, and ANSI B 16.11.

L. Grooved couplings and mechanical fittings shall be UL listed or FM Approved for fire protection service. Plain-end type pipe fittings and couplings shall not be permitted. Snap-On and Strapless Outlet fittings shall not be permitted.

M. All fire sprinkler system piping passing through or crossing building seismic joints, shall contain a flexible expansion loop, designed for seismic movement. Flexible loops shall impart no thrust loads to building structure. Loops shall be located at, or near, the building seismic joint. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Flexible loops shall be capable of movement in the ±X, ±Y, ±Z planes. Flexible seismic loops to be Fireloop as manufactured by The Metraflex Company, Chicago, IL (no known equal).

2.3 VALVES

A. Main system control valves shall be of the indicating gate or butterfly type with monitored supervisory switch.

B. Check valves shall be swing or wafer type, and shall have rubber or composition discs. Check valves shall not be installed in the vertically-downward position unless specifically approved for this position.

C. All drain valves and test valves shall have replaceable rubber or composition discs.

2.4 SPRINKLERS

A. Sprinklers in unfinished areas shall be Quick Response upright, pendent or sidewall, ½" orifice, 155°F rated (or as required by NFPA 13-2010, Section 8.3.2), chrome finish, TYCO Model TY-FRB or approved equal.
B. Pendent sprinklers in the gypsum board ceiling areas of the following spaces shall be provided with Concealed pendent fire sprinklers, Main Lobby, Elevator Lobbies at each floor level, and Large Conference Room at each floor level. Concealed sprinklers shall be 155F, ½” orifice, with white coverplates. TYCO Model RF-II or approved equal.

C. Pendent sprinklers in all other finished ceiling areas shall be Quick Response recessed pendent sprinklers, 155F (or as required by NFPA 13-2012, Section 8.3.2), ½” orifice, chrome finish. TYCO Model TY-FRB or approved equal. Exception: Pendent sprinklers in ceilings with surface-mounted light fixtures and similar obstructions may be protected utilizing chrome pendent sprinklers with matching 2-piece pendent (#401) escutcheons.

D. All new sprinklers subject to mechanical damage, or installed less than 7 feet above finished floor shall be provided with listed sprinkler guards.

E. A minimum of 6 spare sprinklers of each type provided on the Project shall be provided in a suitable metal cabinet, along with one sprinkler wrench appropriate for each type of sprinkler installed. The metal cabinet shall be permanently mounted in a location directed by the SLAC Representative.

2.5 FIRE ALARM AND RELATED EQUIPMENT

A. Waterflow switches shall have (2) SPDT contacts. They shall be installed, and adjusted under this Section.

B. Valve supervisory switches shall have (2) SPDT contacts. They shall be installed, and adjusted under this Section.

PART 3 - EXECUTION

3.1 GENERAL

A. Ream all piping to remove all burrs. Pipe sections shall be cleaned inside to remove all chips and foreign materials prior to making joints.

B. The building shall be fully sprinklered per the requirements of NFPA 13 - 2010 Edition.

C. Welding, torch cutting, and open flames are not permitted inside the building.

D. Install hangers, flexible connections, swing joints, and seismic bracing in accordance with NFPA 13 - 2010 Edition (including Appendix A).

E. Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 - 2010 Edition, ASCE 7 and SLAC Seismic Requirements "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

F. System piping shall be installed such that no joints, fittings or devices occur directly over electrical equipment. Fire sprinkler piping shall not be installed in Dedicated Electrical Spaces as defined in the California Electrical Code Section 110-26 (f)(1)(a).
G. Fire sprinkler system drains shall be consolidated in a 2-inch (minimum) drain riser, and piped to an exterior Sanitary Sewer receptor, connected with an approved Air Gap Fitting.

H. Provide auxiliary drains for all trapped piping. Drains shall be installed at the bottom of the pipe being drained.

I. Install permanent valve identification signs and hydraulic nameplate data as required by NFPA 13 - 2010 Edition. Signs shall be attached by chain or other durable means. Ink or felt-tipped pens shall not be used on hydraulic nameplates or signs. All markings shall be permanent.

3.2 PRODUCT HANDLING

A. Deliver materials and store on site in original containers with seals unbroken and labels intact until time of use, in accordance with the manufacturer's instructions.

B. All materials and equipment shall be carefully handled at all times. Only suitable and proper equipment and appliance shall be used for the safe loading, hauling, unloading, handling, and installation of material.

C. All sprinklers shall be protected during installation with the protective cover provided by the manufacturer. The protective cover shall not be removed until all construction which creates a potential for damage to the sprinkler is completed, including but not limited to mechanical equipment and duct, electrical equipment and conduit, plumbing equipment and piping, wall and ceiling construction, etc.

3.3 JOB CONDITIONS

A. Other trades will be working in the building during the contract period. Coordinate work schedule, material deliveries etc. with the SLAC Representative.

B. Impairments of fire protection systems under the control of the Subcontractor shall be minimized, coordinated with the SLAC Representative, and performed in accordance with NFPA 25. All existing fire protection systems shall be restored to service at the end of each working day. Impairments of existing SLAC fire protection systems shall be performed only by appropriate SLAC personnel.

C. All equipment and material to be furnished and installed on the Project shall be coordinated with the space constraints. All equipment and material shall be fabricated such that complete systems may be broken down into sections suitable for lifting and fitting through passageways without modification to the building unless otherwise noted, or other arrangements are made with the SLAC Representative.

3.4 PENETRATIONS

A. The Subcontractor shall be responsible for all openings and penetrations required for sprinkler piping.
B. Cutting structural members for passing fire sprinkler piping or pipe hanger fastenings will not be permitted except with approval of the SLAC Representative.

C. Suitable means shall be provided at each hole or penetration to maintain/restore the designed fire resistance rating of the wall, ceiling or floor assembly.

D. Install split wall plates or escutcheons where exposed piping passes through a finished floor, wall or ceiling. They shall fit snugly around piping. The finish of escutcheons or wall plates shall match the color of adjacent walls, ceilings or floors.

3.5 PAINTING/FINISH

A. Clean all exposed surfaces of installed piping of oil, dirt, etc. to the SLAC Representative's satisfaction.

B. Remove protective bags and wrappings after painting is completed. All fire sprinklers which have any paint on them shall be replaced. Cleaning of painted fire sprinklers is not permitted.

3.6 FIELD QUALITY CONTROL

A. Upon completion of installation and while piping is still exposed, hydrostatically test the systems at 200 psi (or 50 psi in excess of the system working pressure, whichever is greater) for a period of 2 hours. Any drop in pressure or any leak shall be cause to fail the test and a new test shall be scheduled once repairs are made. A minimum of seventy-two hours notice shall be given to the SLAC Representative and the SLAC Fire Marshal Office Representative prior to any inspection. The Subcontractor shall have all equipment necessary for the inspection available to the SLAC Fire Marshal Office Representative, including a ladder of an appropriate height.

B. A pre-installation inspection of pipe, fittings, and devices is required.

C. The Subcontractor shall be responsible for all leaks.

END OF SECTION 211300
SECTION 230000 – BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Work included in 23 00 00 applies to Division 23 work to provide materials, labor, tools, permits and incidentals to provide and make ready for University’s use heating, ventilation, and air conditioning systems for proposed project.

B. Related Work Specified Elsewhere:
   1. Contents of Section applies to Division 23 specifications.
   2. Requirements of Section are a minimum for Division 23 Sections, unless otherwise stated in each Section, in which case that Section’s requirements take precedence.

1.2 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 23:
   1. ADA Americans with Disabilities Act.
   2. AHJ Authority Having Jurisdiction.
   5. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers.
   6. ASME American Society of Mechanical Engineers.
   8. ASSE American Society of Sanitary Engineering.
   10. CBC California Building Code.
   11. CEC California Electrical Code.
   12. CGA Canadian Gas Association.
   13. CMC California Mechanical Code.
   15. CSA Canadian Standards Association.
   16. DOE Department of Energy.
   17. ETL Electric Testing Laboratories.
   18. FM FM Global.
   19. HI Hydraulic Institute Standards.
   20. HVAC Heating, Ventilating and Air Conditioning.
   22. MSS Manufacturers Standardization Society.
   27. NRCA National Roofing Contractors Association.
   28. NSF National Sanitation Foundation.
   29. OSHA Occupational Safety and Health Administration.
30. SMACNA  Sheet Metal and Air Conditioning Contractors' National Association, Inc.
31. TEMA  Tubular Exchanger Manufacturers Association.
32. TIMA  Thermal Insulation Manufacturers Association.
33. UL  Underwriters Laboratories Inc.
34. USGBC  United States Green Building Council.

B. Provide: To furnish and install, complete and ready for the intended use.
C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.
D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

1.3 REQUEST FOR INFORMATION (RFI’S) (ADDITIONAL REQUIREMENTS TO DIVISION 01)

A. Items listed below shall be in addition to all requirements presented in Division 1. Where sections of Division 1 are more stringent than in this section, the more stringent requirements shall apply.
B. During construction when information is requested provide RFI in format described in this section.
C. Provide complete and legible description of information requested with attached shop drawing indicating location of question.
D. Provide complete drawing and specification references.
E. Provide grid location.
F. Provide proposed solution(s). RFI will not be reviewed without proposed solution. Solution stating, "Subcontractor has no solution" will not be accepted and will be returned.
G. Coordinate proposed solutions with all other trades.
H. Subcontractor must account for a five working day turn-around on all RFI’s.

1.4 SUBMITTALS (ADDITIONAL REQUIREMENTS TO DIVISION 01)

A. Items listed below shall be in addition to all requirements presented in Division 1. Where sections of Division 1 are more stringent than in this section, the more stringent requirements shall apply.
B. Submit complete data for all equipment, fixtures, and materials to be installed.
C. Equipment, materials, and products specifically identified, described, or scheduled on the drawings and named first in the specifications (where a product is not identified on the drawings) are the basis of design. The other manufacturers or suppliers which may be named
in the specification only indicate the general acceptability of the manufacturer or supplier. It is
the Subcontractor's responsibility to research, select, and prove, through the submittal process,
that the specific model, size, or type of the alternate item proposed is equal and will perform
equal to that which is the basis of the design. Operational characteristics for such items as
outlet velocities, power input, sound levels, efficiencies, etc., shall be considered in addition to
the overall performance or output. All deviations from the basis of design shall be noted in the
submittals.

D. Each item submitted shall be labeled or identified the same as on the drawings (SF-1, EF-1,
etc.).

E. The Subcontractor assumes full responsibility that alternative items substituted for the first
named manufacturer will meet the job requirements and is responsible for the cost of redesign
and modifications necessary due to this substitution. Revisions or additional work required due
to the use of substitute materials shall be fully indicated on detailed drawings submitted with the
shop drawings.

F. Mark submittal "Exactly as Specified" or accompanied by a letter from the supplier explaining in
detail what difference, if any, exists between the submitted item and the specified item. Failure
to point out the differences or not properly marking the submittal "Exactly as Specified" will be
considered cause for disapproval. If differences are not indicated and/or not discovered during
the submittal review process, the Subcontractor will still remain responsible for providing
equipment and materials that meet the specifications.

G. Provide computer selections of fans and pump curves, operation characteristics, capacities,
ambient noise criteria, etc., for all equipment. If variable speed systems are employed, ensure
that systems will operate from 20% of rated capacity to 100%.

H. Submit octave band sound power level data at the specified operating conditions for fans, air
handling units, fan powered boxes, and terminal devices.

I. Submit certified test report indicating sound insertion loss and static pressure loss for all sound
attenuators.

J. For vibration isolation equipment, list make and model selected with operating load and
deflection. Indicate frame type where required. Submit manufacturer's product data.

K. Submittal Procedures
   1. Coordination: Coordinate preparation and processing of submittals with performance of
      construction activities. Transmit each submittal sufficiently in advance of performance of
      related construction activities to avoid delay.
      a. Coordinate each submittal with fabrication, purchasing, testing, delivery, other
         submittals and related activities that require sequential activity.
      b. Coordinate transmittal of different types of submittals for related elements of the
         Work so processing will not be delayed by the need to review submittals
         concurrently for coordination.
      c. The University or University's Representative reserves the right to withhold action
         on a submittal requiring coordination with other submittals until related submittals
         are received.
   2. Processing: Allow sufficient review time so that installation will not be delayed as a result
      of the time required to process submittals, including time for re-submittals.
a. Allow two weeks for initial review. Allow additional time if processing must be
delayed to permit coordination with subsequent submittals. The University or
University’s Representative will promptly advise the Subcontractor when a
submittal being processed must be delayed for coordination.
b. If an intermediate submittal is necessary, process the same as the initial submittal.
c. Allow two weeks for reprocessing each submittal.
d. No extension of contract time will be authorized because of failure to transmit
submittals to the University or University’s Representative sufficiently in advance of
the Work to permit processing.

3. Substitutions: Subcontractor shall reimburse Construction Manager and its Consultants
for any review of substitutions at their standard billing rates. The mechanical and
electrical components, and controls for all equipment are selected and sized based on
the equipment specified as the first-name basis of design manufacturer and model
number as indicated on drawings and equipment schedules. If substitutions and/or
equivalent equipment are furnished, it shall be the responsibility of all parties concerned,
involved in, and furnishing the substitute and/or equivalent equipment to verify and
compare the characteristics and requirements of that furnished to that specified and/or
shown. If greater capacity or more materials or labor is required for the design, structure,
support, rough-in, circuitry or connections than for the item specified and provided for,
then it shall be the responsibility of the parties involved in providing the substitute and/or
equivalent items of equipment to provide all compensation for additional charges made
for the proper design, structure, support rough-in, circuitry and connections for the
equipment furnished. No additional charges above the Base Bid shall be allowed for such
revisions. Coordinate with the requirements of “SUBMITTALS”

4. Submittal Transmittal: Package each submittal appropriately for transmittal and handling.
Transmit each submittal from Subcontractor to University or University’s Representative
using a transmittal form. Submittals received from sources other than the Subcontractor
will be returned without action.

5. Schedules: Project schedules indicating proposed work phases and sequences. Include
in schedule as a minimum, approvals, equipment release, delivery, fabrication,
equipment setting, startup, punch, and cleanup.

a. Coordinate submittal schedule with the Subcontractor’s construction schedule.
b. Prepare the schedule in chronological order. Provide the following information:
c. Scheduled date for the first submittal.
d. Related Section number.
e. Submittal category.
f. Name of subcontractor.
g. Description of the part of the Work covered.
h. Scheduled date for re-submittal.
i. Anticipated date for Engineer’s final release or approval.

7. Distribution: Following response to initial submittal, print and distribute copies to the
Engineer, University, subcontractors, and other parties required to comply with submittal
dates indicated. When revisions are made, distribute to the same parties. Delete parties
from distribution when they have completed their assigned portion of the Work and are no
longer involved in construction activities.

8. Schedule Updating: Revise the schedule after each meeting or activity, where revisions
have been recognized or made. Issue the updated schedule to all parties involved.

9. Resubmission Requirements: Make any corrections or change in submittals as required.
It is the responsibility of the Subcontractor to provide submittals as specified. The
engineer will not be required to edit and/or interpret the Subcontractor’s submittals. All
changes made for the Re-submittal shall be indicated in a cover letter with reference to page(s) changed and will reference response to comment. All changes will be required to be clouded in the submittals.

a. Resubmit for review until no exceptions are taken.
b. Review of submittals after first re-submittal:
   1) Cost for Engineer's review borne by Subcontractor.
c. Shop Drawings and Product Data:
   1) Revise initial drawings or data, and resubmit as specified for all initial submittals.
   2) Indicate any changes which have been made other than those requested.
   3) Clearly identify re-submittal by original submittal number and revision number.

10. If excessive review, more than twice for any single submittal, is required, Subcontractor shall reimburse Construction Manager and its Consultants for such review at their standard billing rates.

L. Review Action
1. The Subcontractor is responsible for all data and information on submittals, including quantities, sizes, dimensions, and compliance with the Drawings and Specifications. Checking by the University or University's Representative is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown is subject to the requirements of the Drawings and Specifications. Subcontractor is responsible for dimensions and quantities, which shall be confirmed at the jobsite, and fabrication process and techniques of construction.

2. Except for submittals for record, information for similar purposes, where action and return is required or requested, the University will check each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Subcontractor's responsibility.

M. Product Data
1. Collect Product Data into a single submittal for each element of construction or system.
2. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as Shop Drawings.
3. Product Data Information: includes catalog cuts, acoustical data, sketches, or bulletins indicating performance characteristics and certified performance curves with operating point indicated, features of equipment, controls, instrumentation, valving, equipment dimensions, materials of construction, estimated weight of unit (shipping, installed, and operating), heat rejection load when operating, auxiliaries, specialties, or accessories furnished, roughing-in or anchor diagrams and templates, manufacturer's installation instructions, service clearance requirements, standard color charts, and wiring diagrams.
4. Schematic Drawings shall include elevation and plan views, and indicate all connections, attachments, and details to indicate field required general details of assembly, etc. (Piping, pneumatics, wiring, etc.).
5. Wiring diagrams shall detail wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
   a. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information with above product data:
b. Manufacturer's printed recommendations.
c. Compliance with recognized trade association standards.
d. Compliance with recognized testing agency standards.
e. Application of testing agency labels and seals.
f. Notation of dimensions verified by field measurement.
g. Notation of coordination requirements.
h. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
i. Preliminary Submittal: (Where Subcontractor desires product specific information or preliminary review prior to processing of final submittal.) Submit a preliminary single-copy of Product Data where selection of options is required.
j. Submittals: Submit copies of each required submittal.
k. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
l. Do not proceed with installation until an applicable copy of Product Data applicable is in the installer's possession.
m. Do not permit use of unmarked copies of Product Data in connection with construction.

6. Record Documents:
a. General: Do not use record documents for construction purposes; protect from deterioration and loss, by keeping them in a secure, fire-resistant location; provide access of record documents for the University's reference during normal working hours.

b. Record Drawings: Maintain a clean, undamaged set of blue or black line prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date:
   1) Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
   2) Mark new information that is important to the University, but was not shown on Contract Drawings or Shop Drawings.
   3) Note related Change Order numbers where applicable.
   4) Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

c. Prepare record documents including indication of the following installed conditions:
   1) Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
   2) Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 15 - Mechanical Identification. Indicate actual inverted and horizontal locations of underground piping.
   3) Equipment locations (exposed and concealed), dimensioned from prominent building lines.
4) Contract Modifications, actual equipment and materials installed.

7. As-Built Drawings: Upon completion of all work, the Subcontractor shall create "as-built" drawings from the record drawings. This shall be done in Auto-Cad and shall accurately reflect the as-built conditions. After completion of the 'as-built' documents, the Subcontractor shall submit an electronic file together with a hard copy (blueline) for review by Construction Manager/Engineer, the Subcontractor shall provide an electronic file and two (2) sets of hard-copy (blueline) documents for submittal to the University.

8. Delivery, Storage and Handling:
   a. Deliver products, materials and equipment marked with product names, model numbers, types, grades, compliance labels, and other information needed for identification. Inspect items for shipping damage and refuse, return, or refurbish items to the satisfaction of the University. Maintain delivery records for inventory control and for use in processing payment request vouchers. Cross check delivery records with project schedule so as to eliminate work stoppages due to material shortages.
   b. Store products, materials, and equipment in a manner to prevent damage and degradation. Store items on skids or pallets, elevated above the floor or grade. Store items subject to moisture damage in a dry location. Retain protective shipping covers, crates, and cartons during storage. Protect items from contamination by jobsite dirt and debris and other foreign matter. Segregate items into groups of like type for jobsite storage. Provide a secure, fenced and lighted area for outside jobsite storage.
   c. Handle products, materials, and equipment in accordance with manufacturer's recommendations and recognized industry standards. Utilize lifting lugs, and designated lift points when hoisting equipment. In all cases carefully handle, transport, and position items to prevent damage during construction. After placement or installation, cover items with tarps or sheeting where required to protect from damage during construction.

N. Submit copies of certificates of code authority acceptance, test data, parts lists, maintenance information for equipment, valves, balancing reports, and other special guarantees, certificates of warranties, and the like, specified elsewhere herein or indicated on Drawings.

O. Submit mechanical/plumbing/fire protection code authority certification of inspection.

1.5 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence, and include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Mechanical Drawings: Drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., ducts and piping) and equipment proposed to assure that systems and equipment will fit in available space. Subcontractor is responsible for design and construction costs incurred for equipment other than basis of design, including but not limited to architectural, structural, electrical, fire sprinkler, and HVAC.

SECTION 230000 – BASIC HVAC REQUIREMENTS

Page 7 of 12
June 19, 2012
C. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws:
1. NFPA.
2. OSHA.
3. Related supplements and standards.
9. State of California and local jurisdictional requirements.

D. Permits and Inspections:
1. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by public AHJ.
2. Refer to General and Supplementary Conditions for payment of water and sewer service connection fees.
3. Obtain certificates of inspection from AHJs and deliver to University before final acceptance.
4. Each trade to consult local building department and utility companies prior to commencement of work to ascertain existence and location of existing underground utilities. Protect existing service against damage and interruption of use, and reroute as may be necessary to accomplish new work. Include costs for materials and installation for rerouting as specified for new work in bid price.

E. Regulatory Requirements:
1. UL and CSA Compliance: Provide units which are UL, ETL, and CSA listed.
2. ASME Compliance: Provide units which are ASME listed when boilers which exceed 200,000 BTUH, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

1.6 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Construction Manager prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer’s shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Construction Manager.

PART 2 - PRODUCTS

2.1 HAZARDOUS MATERIALS
A. Do not use products containing asbestos, lead, arsenic, or any other material defined by EPA as hazardous to human or animal life.

2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials and equipment used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be UL or CSA approved or acceptable by state, county, and city authorities. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Articles and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drain pans, drains, fire dampers, control dampers, control operators, valves, motors, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Construction Manager in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Construction Manager prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

3.2 REVIEW BY ENGINEER

A. Notify Construction Manager/Engineer, in writing, at following stages of construction so that Construction Manager/Engineer may, at their option, visit site for review and construction observation:
   1. Underground piping installation prior to backfilling.
   2. Prior to covering walls.
   3. When ceiling installation is started.
   4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
   5. When ductwork installation starts.
   6. When installation starts for each different major type of equipment.
   7. When lines or ducts are to be permanently concealed by construction or insulation systems.
8. When balancing and testing is started.

3.3 OPERATING DURING CHANGEOVER
A. During remodeling of existing structure, or addition of a structure to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.
B. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, wiring, and the like, to point of connection.
C. Perform actual transfer to new service at off-peak time, as coordinated with University. Once changeover is started, pursue it to its completion, to keep interference to a minimum.

3.4 MUTILATION
A. Repair mutilation of building around pipes, ducts, and the like.

3.5 DEMOLITION
A. Scope:
   1. It is intent of these documents to provide necessary information and adjustments to mechanical system required to meet code, and accommodate installation of new work.
   2. Coordinate with University so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas.
   3. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate University for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify University if utilities are found which are not shown on Drawings.
B. Equipment: Unless otherwise directed, equipment or fittings being removed as part of the demolition process are the University's property. Remove other items not scheduled to be reused or relocated from job site as directed by University.
C. Unless specifically indicated on the Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.
D. Unless specifically indicated on the Drawings, remove unused equipment, fittings, rough-ins, connectors, etc. Removal is to be to a point behind finished surfaces (floors, walls, ceilings, etc.).

3.6 ELECTRICAL INTERLOCKS
A. Where equipment motors are to be electrically interlocked with other equipment for
simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

3.7 EQUIPMENT SELECTION AND SERVICEABILITY
A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to University.
B. Maintain design intent where equipment other than as shown in Contract Documents is provided. Where equipment requires piping arrangement, control diagrams, or sequencing different from that indicated in Contract Documents, provide electrical motors, wiring, controls, or other required electrical components at no additional cost to University.

3.8 DELIVERY, STORAGE AND HANDLING
A. Deliver, store and handle materials and equipment in a manner to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.
B. Replacement: In event of damage, immediately make repairs and replacements necessary.

3.9 DEMONSTRATION
A. Upon completion of work and adjustment of equipment, test systems to demonstrate to University's Representative and Construction Manager that equipment furnished and installed or connected under provisions of these Specifications functions mechanically in a manner required.
B. Manufacturer’s Field Services: Furnish services of a qualified person for a period of not less than sixteen hours, at a time approved by University, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of University that entire system is operating in a satisfactory manner and complies with requirements of other trades or Contractors that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.10 CLEANING
A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

3.11 INSTALLATION
A. Install equipment in accordance with manufacturer's installation instructions, plumb and level,
firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of mechanical systems.
   2. Furnish sufficient refrigerant and dry nitrogen for pressure testing under manufacturer's supervision.
   3. Provide and install additional fan sheaves to obtain design capacities. Coordinate exact requirements with balancing firm.

3.12 PAINTING

A. Ferrous Metal: After completion of mechanical work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, and the like, with one coat of black asphalt varnish or black enamel suitable for hot surfaces.

B. Machinery:
   1. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Construction Manager.
   2. See individual equipment Specifications for other painting.
   3. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

C. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Construction Manager.

3.13 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Construction Manager that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   1. Testing and balancing reports.
   2. Cleaning.
   3. System balancing and balancing logs.
   4. Operating and Maintenance Manuals.
   5. Training of operating personnel.
   6. Record Drawings.
   7. Guaranty certificates.
   8. Start-up and test document.

END OF SECTION 230000
SECTION 230593 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Component check
B. System balancing
C. Operating tests

1.2 RELATED SECTIONS

A. Section 010000 – General Requirements
B. Section 011100 – Hold Points
C. Section 230000 – Basic HVAC Requirements

1.3 REFERENCES

A. American National Standards Institute (ANSI): ANSI S12.1 Guidelines for Preparation of Standard Procedures to Determine the Noise Emission from Sources
B. Associated Air Balance Council (AABC): AABC 12173 National Standards for Field Measurements and Instrumentation – Total System Balance
C. National Environmental Balancing Bureau (NEBB): Procedural Standards for Testing Balancing Adjusting of Environmental Systems

1.4 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

K. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

L. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

M. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

N. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

O. TAB: Testing, adjusting, and balancing.

P. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

Q. Test: A procedure to determine quantitative performance of systems or equipment.

R. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.5 SUBMITTALS

A. Qualification Data: Within 5 days from Subcontractor's Notice to Proceed, submit 6 copies of evidence that the TAB firm and project's TAB team members meet the qualifications specified in Part 1.06 "Quality Assurance".

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
C. Warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. TAB Conference: Meet with Subcontractor on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers’ authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location. Agenda items shall include the following:
1. Submittal distribution requirements.
3. TAB plan.
4. Work schedule and Project-site access requirements.
5. Coordination and cooperation of trades and subcontractors.
6. Coordination of documentation and communication flow.
7. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1) Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2) Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


D. Instrumentation Type, Quantity, and Accuracy: As described in AABC’s "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB’s "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents.
   2. Verify that quantities and locations of balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

E. Examine system and equipment test reports.

F. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

H. Examine HVAC equipment to ensure that clean filters have been installed and equipment with functioning controls is ready for operation.

I. Examine plenum ceilings to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

J. Examine equipment for installation and for properly operating safety interlocks and controls.

K. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing on each system according to the procedures contained in AABC’s "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB’s "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems’ "as-built" duct layouts.
C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections and functioning.

I. Check for proper sealing of air-handling unit components.

J. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
   4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   5. Adjust fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
   6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved: Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

SECTION 230593 – TESTING, ADJUSTING AND BALANCING

Page 6 of 13
June 19, 2012
2. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments: Measure terminal outlets using a direct-reading hood or outlet manufacturer’s written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

D. For spaces with pressurization being monitored and controlled automatically, observe and adjust

3.7 PROCEDURES FOR SOUND-LEVEL MEASUREMENTS

A. Perform sound-pressure-level measurements with an octave-band analyzer complying with ANSI S1.4 for Type 1 sound-level meters and ANSI S1.11 for octave-band filters. Comply with requirements in ANSI S1.13, unless otherwise indicated.

B. Calibrate sound meters before each day of testing. Use a calibrator provided with the sound meter complying with ANSI S1.40 and that has NIST certification.

C. Use a microphone that is suitable for the type of sound levels measured. For areas where air velocities exceed 100 fpm, use a windscreen on the microphone.

D. Perform sound-level testing after air and water balancing and equipment testing are complete.

E. Close windows and doors to the space.

F. Perform measurements when the space is not occupied and when the occupant noise level from other spaces in the building and outside are at a minimum.

G. Clear the space of temporary sound sources so unrelated disturbances will not be measured. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.
H. Take sound measurements at a height approximately 48 inches above the floor and at least 36 inches from a wall, column, and other large surface capable of altering the measurements.

I. Take sound measurements in dBA and in each of the 8 unweighted octave bands in the frequency range of 63 to 8000 Hz.

J. Take sound measurements with the HVAC systems off to establish the background sound levels and take sound measurements with the HVAC systems operating: Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.

K. Perform sound testing at one location on Project for each of the following space types. For each space type tested, select a measurement location that has the greatest sound level.
   1. Private office.
   2. Open office area.
   3. Conference room.
   4. Auditorium/large meeting room/lecture hall.
   5. Classroom/training room.
   6. Patient room/exam room.
   7. Sound or vibration sensitive laboratory.
   8. Hotel room/apartment.
   9. Each space with a noise criterion of RC or NC 25 or lower.
  10. Each space with an indicated noise criterion of RC or NC 35 and lower that is adjacent to a mechanical equipment room or roof mounted equipment.
  11. Inside each mechanical equipment room.

3.8 PROCEDURES FOR INDOOR-AIR QUALITY MEASUREMENTS

A. After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.

B. Observe and record the following conditions for each HVAC system:
   1. The distance between the outside-air intake and the closest exhaust fan discharge, cooling tower, flue termination, or vent termination.
   2. Specified filters are installed. Check for leakage around filters.
   3. Cooling coil drain pans have a positive slope to drain.
   4. Cooling coil condensate drain trap maintains an air seal.
   5. Evidence of water damage.
   6. Insulation in contact with the supply, return, and outside air is dry and clean.

C. Measure and record indoor conditions served by each HVAC system. Make measurements at multiple locations served by the system if required to satisfy the following:
   1. Most remote area.
   2. One location per floor.
   3. One location for every 5000 sq. ft.

D. Measure and record the following indoor conditions for each location two times at two-hour intervals, and in accordance with ASHRAE 113:
   1. Temperature.
   2. Relative humidity.
   3. Air velocity.
5. Concentration of carbon monoxide (ppm).
7. Formaldehyde (ppm).

3.9 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.
B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
C. Record controller settings and note variances between set points and actual measurements.
D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.
F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
G. Check the interaction of electrically operated switch transducers.
H. Check the interaction of interlock and lockout systems.
I. Check main control supply-air pressure and observe compressor and dryer operations.
J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.11 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in Part 3.01 "Examination", prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures,
procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   9. Signature of TAB firm who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
       a. Indicated versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer, type size, and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
       a. Settings for outside-, return-, and exhaust-air dampers.
       b. Conditions of filters.
       c. Cooling coil, wet- and dry-bulb conditions.
       d. Face and bypass damper settings at coils.
       e. Fan drive settings including settings and percentage of maximum pitch diameter.
       f. Inlet vane settings for variable-air-volume systems.
       g. Settings for supply-air, static-pressure controller.
       h. Other system operating conditions that affect performance.
E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer’s serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.
2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat coil static-pressure differential in inches wg.
   g. Cooling coil static-pressure differential in inches wg.
   h. Heating coil static-pressure differential in inches wg.
   i. Outside airflow in cfm.
   j. Return airflow in cfm.
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

G. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Indicated airflow rate in cfm.
g. Indicated velocity in fpm.
h. Actual airflow rate in cfm.
i. Actual average velocity in fpm.
j. Barometric pressure in psig.

H. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Test apparatus used.
      d. Area served.
      e. Air-terminal-device make.
      f. Air-terminal-device number from system diagram.
      g. Air-terminal-device type and model number.
      h. Air-terminal-device size.
      i. Air-terminal-device effective area in sq. ft.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary airflow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
      e. Final airflow rate in cfm.
      f. Final velocity in fpm.
      g. Space temperature in deg F.

I. Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:
   1. Date and time of test. Record each tested location on its own NC curve.
   2. Sound meter manufacturer, model number, and serial number.
   3. Space location within the building including floor level and room number.
   4. Diagram or color photograph of the space showing the measurement location.
   5. Time weighting of measurements, either fast or slow.
   6. Description of the measured sound: steady, transient, or tonal.
   7. Description of predominant sound source.

J. Indoor-Air Quality Measurement Reports for Each HVAC System:
   1. HVAC system designation.
   2. Date and time of test.
   3. Outdoor temperature, relative humidity, wind speed, and wind direction at start of test.
   4. Room number or similar description for each location.
   5. Measurements at each location.
   6. Observed deficiencies.

K. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Measure sound levels at two locations.
      e. Measure space pressure of at least 10 percent of locations.
      f. Verify that balancing devices are marked with final balance position.
      g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the Subcontractor.
   2. TAB firm test and balance engineer shall conduct the inspection in the presence of the Subcontractor.
   3. The Subcontractor shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
   6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
   7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION 230593
SECTION 233100 – DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Materials, installation and testing of HVAC ductwork and accessories, including the following:
   1. Heating and air conditioning supply and return systems.
   2. Outside air systems.
   3. Exhaust systems.
   4. Ductwork hangers.
   5. Plenums.

1.2 QUALITY ASSURANCE

A. Unless otherwise noted, where the Specification refers to SMACNA in reference to sheet metal or flexible ductwork, this refers to HVAC Duct Construction Standards, Metal and Flexible, latest edition, as published by SMACNA.

B. Unless otherwise noted, where the Specification refers to TIMA in reference to fiberglass ductwork, this refers to Fibrous Glass Duct Construction Standards, latest edition, as published by TIMA.

C. Provide duct systems per CMC, latest edition, and all referenced standards.

D. Have available at the project field office a copy of the referenced standards.

1.3 SUBMITTALS

A. Provide shop drawings for duct materials, flues.

B. Submit duct pressure testing reports. Provide individual reports for each AHU duct system.

1.4 AIR DISTRIBUTION DUCT SYSTEM

A. General: All ductwork, including collars, register boxes, fire dampers, exhaust fans, ventilation louvers, roof vents and screens, as well as all dampers and any other miscellaneous items not specifically mentioned but necessary for a complete installation. Apply the latest standards of SMACNA and ASHRAE with respect to sheet-metal gauge and general construction for round and rectangular ducts.
PART 2 - PRODUCTS

2.1 GALVANIZED SHEET-METAL DUCTWORK


2.2 FLEXIBLE DUCTS

A. General: Comply with CMC, latest edition, Class 0 or Class 1.

B. Standard factory fabricated product, construct an inner wall of impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix. Cover the assembly with fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier. UL 181 listed Class 1 flexible air duct material. Overall thermal transmission no more than 0.25 (BTU/in)/(hr/sq.ft./deg. F) at 75F differential, per ASTM C335. Vapor transmission value no more than 0.10 perm, per ASTM E96. Rated for a minimum of 4-inch w.g. positive pressure and 1-inch w.g. negative pressure.

C. Air friction correction factor of 1.3 maximum at 1000 FPM. Working air velocity of at least 2000 FPM. Flame spread rating no more than 25. Smoke development rating no more than 50 as tested per ASTM E84. Must have cataloged data on insertion loss characteristics, minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter and 500 Hz.

D. Manufacturers: J. P. Lamborn Co., Norflex, Clevaflex, Genflex, Atco, Flexmaster, Thermaflex, or approved.

2.3 FACTORY FABRICATED METAL ROUND AND FLAT OVAL DUCTWORK

A. General: Provide per CMC Duct Construction Standards, latest edition, and ASTM A527 Class 0. Round sheet metal, spiral lock seam type. Fittings: Same construction as the duct. Tap in fittings not allowed. Duct sealer: Specifically formulated for sealing field joints for round spiral lock-seam duct systems.

2.4 SHEET-METAL DUCT SEALER

A. Hardcast "Duct-Seal 321" or United McGill. Indoor/outdoor, low VOC (<20 GPL), water based with fiber reinforcement.

2.5 PREFABRICATED DUCT JOINTS

A. Manufactured flanged traverse rectangular and round duct joints.

B. Manufacturers: Ductmate, Mez, Ward Duct Connectors, Lockformer TDC, or approved.
PART 3 - EXECUTION

3.1 INSTALLATION

A. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout as required to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, such alterations not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or run as shown on the Contract Drawings. Make such determination by Construction Manager. In the event Construction Manager determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the University.

B. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Construction Manager prior to any fabrication. Provide fittings construction per SMACNA.

C. Connect duct assemblies such as ductwork, plenums, etc., and operating machines or mechanisms such as fans, air conditioners, etc., with flexible connections per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.

E. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.

F. Install single thickness turning vanes in square throat rectangular elbows and in tees. Provide 3/4-inch trailing edge on turning vanes, turned slightly past parallel to the duct.

G. Duct sizes indicated are free inside dimensions including where internal lining is shown.

H. Provide galvanized sheet-metal duct material for all ducts unless otherwise indicated or specified.

I. Provide temporary closures of open ducts during construction to prevent dust and debris from entering the system.

J. Flexible Duct:
   1. Install flexible duct with bend radius equal to 1.5 times the diameter. Minimum length 2 feet. Maximum length 5 feet, unless noted otherwise.
   2. Provide round neck grilles/diffusers or square-to-round transitions. No flex duct connections directly to square neck allowed.
   3. Flex duct allowed only for vertical drops to diffusers. Maximum offset angle from vertical: 30 degrees.
   4. Approved for use on supply ducts only; not allowed for return or exhaust.
   5. Flex duct allowed in concealed spaces above lay-in ceilings only.

K. Fabricate ductwork and all sheet metal work of prime grade, lock forming quality steel in accordance with the current issues of the ASHRAE "Guide" and SMACNA standards and installed in strict conformance with SMACNA standards.
L. Submit shop drawings for approval for all ductwork. All ductwork to be sheet metal.

M. Construct ductwork upstream of VAV boxes for 4-inch pressure class; downstream duct 1-inch pressure class. All other duct 2-inch pressure class.

N. Round spiral duct and fittings or where required due to available clearances, use flat oval ductwork and fittings upstream of terminal units manufactured by United Sheet Metal, Rolok or approved in accordance with ASTM A527.

O. Seal all joints and seams in supply, exhaust, and return air ductwork and plenums.

P. Fabricate ductwork and plenums with a smooth inside surface and support and brace to prevent sagging and vibration at any time. Provide galvanized steel angles for reinforcing and bracing.

Q. Joints:
   1. Carefully cut and trim all joints and seams in fabricated ducts and fitting to form a closed joint with no portion of the duct or fitting protruding into the air stream.
   2. Seal all joints in sheet-metal ducts in concealed locations (such as enclosed ceiling spaces) with Hardcast joint sealant system applied in accordance with manufacturer’s recommendations, or use Ductmate-type joints.
   3. Seal all joints in sheet-metal ducts in exposed locations with sealant system applied in accordance with manufacturer’s recommendations. Wipe off excess sealer on duct to give a clean finish, or use Ductmate-type joints.
   4. Standard gray duct tape not allowed.

R. All fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.

S. Crimp flat duct surfaces diagonally or beaded regardless of size, unless acoustically lined.

T. Fabricate all duct size transitions with a slope of not more than 1 foot to 5 feet where possible, but in no case more than 1 foot in 3 feet.

U. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width. Where necessary, square elbows may be used, with maximum available inside radius and with fixed single thickness curved vanes, with trailing edge extended 3/4 inch.

V. Provide flexible connectors at connections to all equipment, in ducts crossing building expansion joints and may be used at connections of dissimilar metals. Flexible Connections: Minimum 16 ounce airtight "Ventglass" noncombustible fabric with fire retardant neoprene coating on outside, fastened with bolted galvanized steel bands. Maintain a minimum 1-inch space between the connecting surfaces.
Duct Hangers and Supports:

1. Hang rectangular sheet-metal ducts with a cross sectional area of less than 7 sq.ft. with galvanized strips of No. 16 USS gauge steel 1 inch wide, and all larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at 8 feet on center, as detailed, or per SMACNA.

2. Anchor all ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts or piping.

3. For round sheet-metal ducts, provide duct support in accordance with SMACNA Guidelines. Verify type of building construction.

4. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.


W. Ductwork not to be supported from the roof deck. Hang ducts from beams, joists or supplementary structural members. Do not hang ductwork from joist bridging or from other ducts. Ductwork can be supported from the roof deck if approved by the structural engineer.

X. Although not necessarily indicated on the Drawings, provide turning vanes at all mitered elbows, opposed blade balancing dampers with locking quadrants at branch ducts, volume extractors and any other applicable devices necessary for minimum duct resistance and proper system air balancing. Sufficiently stiffen all dampers to prevent noise or vibration and in no case be lighter than 20 gauge steel. Provide with accessibly located adjuster, manufactured by Young Regulator Co., Parker Kalon Corporation, or approved.

Y. Construct all exterior ductwork or ductwork which is otherwise exposed to weather watertight.

Z. Increase the size of all sheet-metal ducts as required to accommodate insulation lining.

AA. Locate access doors in ductwork as required for service of fire dampers, automatic dampers and other items requiring maintenance or inspection.

BB. Paint inside surface of all bare ductwork which is visible through face of grilles with flat black paint.

3.2 DUCTWORK PRESSURE TESTING

A. Test ductwork prior to connection to fan equipment. Repair leaks and retest until stipulated results are achieved. All pressure testing to meet the following leakage classes below as a minimum (ASHRAE Chapter 21, Table 6):

1. Leakage class to be as defined below as a minimum.
**Minimum Duct Leakage Classification**

<table>
<thead>
<tr>
<th>Duct Type</th>
<th>Leakage Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal (flexible excluded)</td>
<td></td>
</tr>
<tr>
<td>Round and flat oval</td>
<td>3</td>
</tr>
<tr>
<td>Rectangular</td>
<td></td>
</tr>
<tr>
<td>≤2 inches of water</td>
<td>12</td>
</tr>
<tr>
<td>(both positive and negative pressures)</td>
<td></td>
</tr>
<tr>
<td>&gt;2 and ≤10 inches of water</td>
<td>6</td>
</tr>
<tr>
<td>(both positive and negative pressures)</td>
<td></td>
</tr>
</tbody>
</table>


3. Test supply systems prior to connecting VAV boxes.

4. Perform all tests in the presence of University's Representative. Give 48 hours advance notice before commencement of each test.

5. Test ductwork systems in sections as large as possible and record all test results according.

6. Coordinate testing with ceiling installation.
   a. Provide sheet-metal plates and install between each duct test section (applies to main-to-main fittings, branch-to-branch fittings and main-to-main fittings). At each plate location, fabricate joint with Ductmate. Insert 14 gauge sheet metal between Ductmate using a neoprene gasket on both sides of metal plate.
   b. Leave plates in place until isolated section has been tested and approved by University's Representative.
   c. Once sections have passed test, remove plates and reattach Ductmate joints. After fan unit is running, test joint for leakage by using a mixture of soap and water. If any noise or bubbling occurs, reseal joint. University's representative to witness this procedure.

### 3.3 MOUNTING FOR SIDEWALL GRILLES AND REGISTERS

A. All mounting heights indicated on Drawings from finish floor to lower edge of grille or register. Exception: If note on Drawings states for example "Down 6 inches," this indicates measurement from ceiling to top edge of grille or register.

B. Install all sidewall return air grilles for "sight-tight" visibility at eye level (position blades to obscure visibility from floor level).

### 3.4 GRILLE AND EXPOSED DUCT CLEANING

A. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out all accumulation of particles from grilles and diffusers prior to acceptance.

B. Clean exterior surface of all ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured condition.
C. All exposed duct and grilles shall remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

END OF SECTION 233100
SECTION 260000 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electrical systems required for this work include labor, materials, equipment, and services necessary to complete installation of electrical work shown on, specified herein or required for a complete operable facility and not specifically described in other Sections of these Specifications. Among the items required are:
      a. Branch circuit wiring from the distribution panels for lighting, receptacles, and other detailed circuit wiring.
      b. Luminaires, control switches, receptacles, supports and other accessory items.

1.2 GENERAL REQUIREMENTS

A. Provide the following in compliance with Division 01 requirements:
   1. Product substitutions.
   2. Product data.
   3. Delivery, storage and handling.
   4. Project/site conditions.
   5. Sequencing and scheduling.
   6. Closeout documentation.
   7. Record Drawings.
   8. Cutting and patching.

B. The following requirements are in addition to requirements in Division 01:
   1. Closeout Documentation: Submit electrical code authority certification of inspection. Include documentation of onsite electrical testing that was performed.
   2. Record Drawings:
      a. Show changes and deviations from the Drawings. Include written Addendum and change order items.
      b. Make changes to drawings in electronic format. Obtain electronic copy from Project Manager, use the same version of AutoCAD to prepare record drawings as was used by the Project Manager. Provide electronic copy and hard copy to Project Manager for review.
      c. Revise Changes to panelboard directory. Changes to panel directory shall be typed.

1.3 SUBMITTALS

A. Refer to Division 01, General Requirements.

B. Shop Drawings:
1. Unless otherwise approved, provide Electrical Shop Drawings and product submittals at one time in a vinyl covered three-ring loose-leaf binder.

2. Clearly reference each item by page and paragraph to applicable portion of Specifications.

3. Specifically note specified features and performance data on submittal.

4. Check Shop Drawings for space requirements and conformance with Specifications and mark corrections and approval on Shop Drawings prior to submittal to Project Manager.

5. The engineer will review the original submittal and one resubmittal for the same product. Additional resubmittals will be reviewed on an hourly rate, payable by the Subcontractor.

6. Partial submittals or submittals not properly formatted as indicated above, are subject to return without review for the Subcontractor to correct.

1.4 QUALITY ASSURANCE

A. Conform to the latest adopted version of the National Electrical Code (NEC) 2011.

B. Obtain electrical permits, plan review, and inspections from local AHJs.

C. Furnish products listed by UL or other testing firm acceptable to AHJ.

1.5 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 26:

1. ADA Americans With Disabilities Act.

2. AHJ Authority Having Jurisdiction.


6. CBC California Building Code

7. CFC California Fire Code

8. DOE Department of Energy.


10. FM FM Global.

11. HVAC Heating, Ventilating and Air Conditioning.


13. IEEE Institute of Electrical and Electronics Engineers.


15. LEED Leadership in Energy and Environmental Design.


18. OSHA Occupational Safety and Health Administration.

19. UL Underwriters Laboratories Inc.


B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing,
protecting, cleaning and similar operations at the project site to complete items of work furnished by others.

1.6 TECHNICAL DATA

A. Immediately after selection by University, the successful bidder shall prepare and submit to Project Manager the following information.
   1. Raceways.
   2. Wires, cables, and connectors.
   4. Wiring devices and device covers.
   5. Circuit and motor disconnects.
   7. Electrical service.
   8. Grounding.
   10. Contactors and control devices.
   11. Lighting and lighting controls.
   12. Other signal and communication systems related to this project.

1.7 SEQUENCING AND SCHEDULING

A. For the proper execution of the work, cooperate with other crafts and contracts as needed.

B. To avoid installation conflicts thoroughly examine the complete set of Contract Documents. Resolve conflicts with Project Manager prior to installation.

C. Provide electrical equipment compatible with, acknowledge and accommodate the requirements of other trades. Resolve without additional cost to University those details necessary to assure that the electrical system properly and completely function together when assembled and achieve required design criteria and performance and conform to requirements of governing codes and regulatory agencies.

D. Connection to the power supply equipment status shall be controlled through the lockout/tag out (LOTO) program. Restrict access to equipment per the arc flash label boundaries whenever electrical parts are exposed, whether or not they are energized.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide like items from one manufacturer, such as luminaire types, switches, receptacles, breakers, and the like.
2.2 MATERIALS

A. Provide new electrical materials of the type and quality detailed, listed by UL, bearing their label wherever standards have been established. Indicated brand names and catalog numbers are used to establish standards of performance and quality. The description of materials listed herein governs in the event that catalog numbers do not correspond to materials described herein.

B. Provide material and equipment that is acceptable to AHJ as suitable for the use indicated. For example, provide wet labeled equipment in locations that are wet.

2.3 FIRESTOPPING

A. Provide fire stopping patchwork where conduits pass through fire rated walls or floors. Maintain fire rating integrity of walls or floors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Construction Documents: Examine the entire set of Drawings to avoid conflicts with other systems. Determine exact route and installation of electrical wiring and equipment with conditions of construction.

B. Clarification: Should the Electrical Documents indicate a condition conflicting with the governing codes and regulations, refrain from installing that portion of work until clarified by Project Manager.

3.2 INSTALLATION

A. Install electrical equipment complete as directed by manufacturer’s installation instructions. Obtain installation instructions from manufacturer prior to rough-in of the electrical equipment, examine the instructions thoroughly. When requirements of the installation instructions conflict with the Contract Documents, request clarification from Project Manager prior to proceeding with the installation.

B. Do not install electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block the area passage’s intended usage.

C. Noise Control:
   1. Do not install outlet boxes back to back. Do not use straight through boxes.

3.3 FIELD QUALITY CONTROL

A. Tests:
1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified in Division 26. Refer to individual Specification Sections for required tests. Document tests and include in Closeout Documents.

2. During site evaluations by Project Manager provide an electrician with tools to remove and replace trims, covers, devices, and the like, so that a proper evaluation of the installation can be performed.

3.4 CLEANING

A. Remove dirt and debris caused by the execution of the electrical work.

B. Leave the entire electrical system installed under this Contract in clean, dust-free and proper working order.

C. Vacuum clean interiors of electrical equipment enclosures.

3.5 DEMOLITION

A. Scope:
   1. Coordinate with the University so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas. The University will cooperate to the best of their ability to assist in a coordinated schedule, but will remain the final authority as to time of work permitted.
   2. Existing Conditions: Determine the exact location of existing utilities and equipment before commencing work, compensate the University for damages caused by the failure to locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify University if utilities are found which are not shown on Drawings.

B. Equipment: Unless otherwise directed, luminaires being removed as part of the demolition process are the University’s property. Remove other equipment not scheduled to be reused or relocated from the job site as directed by University.

C. Execution:
   1. Remove existing luminaires, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless specifically shown as retained or relocated on Drawings.
   2. Maintain electrical continuity of existing systems. Remove or relocate electrical boxes, conduit, wiring, equipment, luminaires, and the like, as may be encountered in removed or remodeled areas in the existing construction affected by this work. Remove and restore wiring which serves usable existing outlets clear of the construction or demolition. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass the abandoned outlets. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of the construction or demolition and maintain service to the existing load.
   3. Extend circuiting and devices in existing walls to be furred out.
   4. Remove abandoned wiring to leave site clean.
5. Keep outages to occupied areas to a minimum and prearrange outages with the University. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specific dates and hours and the maximum durations. Compensate the University for any damages resulting from unscheduled outages or for those not confined to the preapproved times.

6. Verify a location for storage of materials, supplies, tools, rubbish, and the like, prior to start of work.

7. If any existing electrical equipment contains PCBs (polychlorinated biphenyl), replace with new.

8. Properly dispose of removed/replaced equipment (fluorescent lamps, fluorescent lamp ballasts, transformers, and the like) containing hazardous materials.

3.6 CONTINUITY OF SERVICE

A. No interruption of services to any part of existing facilities will be permitted without express permission in each instance from the University. Obtain written permission from the University for any interruption of power, lighting or signal circuits and systems.

B. If overtime is necessary, there will be no allowance made by University for extra expense for such overtime or shift work, due to maintaining continuity of service herein required.

C. Organize work to minimize duration of power interruption.

END OF SECTION 260000
SECTION 260519 – WIRES, CABLES AND CONNECTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wires and cables.
   2. Connectors.
   3. Lugs and pads.

1.2 SYSTEM DESCRIPTION

A. Provide wires, cables, connectors, lugs, and the like for a complete and operational electrical system.

1.3 SUBMITTALS

A. Provide product data for the following equipment:
   1. Wires.
   2. Cables.
   3. Connectors.
   4. Lugs.

B. Provide the insulation cable testing report in the project closeout documentation, see Project Closeout Requirements in Division 01.

1.1 REFERENCED STANDARDS

A. General:
   1. The following documents form part of the Specifications to the extent stated. Bring conflicts between Specifications, Drawings, and the referenced standards to the attention of the Project Manager, in writing, for resolution before taking any related action.
   2. The editions (date) for the of the referenced standards shall be as follows:
      a. Standards referenced in the CBC. The edition shall be that required by the CBC adopted by SLAC on the date the Notice to Proceed with the Work is given.
      b. Other Standards: The edition shall be that in effect the date the Notice to Proceed with the Work is given.

C. Conform to the latest adopted version of the National Electrical Code (NEC).

D. Furnish products listed by UL or other testing firm acceptable to AHJ.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Wires and Cables: Carol, General Cable, Okonite, Southwire, or approved.

B. Connectors: Stranded conductors by Anderson, Burndy, Ilsco, Thomas & Betts, or approved.

C. Splices:
   1. Branch Circuit Splices: Ideal, Scotch-Lock, 3M, or approved.
   2. Feeder Splices: Compression barrel splice with two layers Scotch 23 and four layers of Scotch 33+ as vapor barrier.

2.2 WIRES AND CABLES

A. Copper, 600 volt rated throughout. Conductors 12AWG and larger will be stranded.

B. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back.

C. Color Code Conductors as Follows:

<table>
<thead>
<tr>
<th>PHASE</th>
<th>208 VOLT WYE</th>
<th>480 VOLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B</td>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Isolated Ground</td>
<td>Green w/yellow trace</td>
<td>N/A</td>
</tr>
</tbody>
</table>

D. Conductors 3AWG and larger, minimum insulation rating of 75C.

E. Insulation types THWN-2 or XHHW-2. Minimum insulation rating of 90C for branch circuits.

2.3 CONNECTORS

A. Copper Pads: Drilled and tapped for multiple conductor terminals.

B. Lugs: Compression type for use with stranded branch circuit or control conductors; mechanical lugs not acceptable. Manufacturers: Anderson, Ilsco, Panduit, Thomas & Betts, 3M, or approved.

C. Conductor Branch Circuits: Wire nuts with integral spring connectors for conductors 18 through 8AWG. Push-in type connectors where conductors are not required to be twisted together are not acceptable. Manufacturers: 3M, Ideal, or approved.


2.4 LUGS AND PADS
A. Ampacity: Cross-sectional area of pad for multiple conductor terminations to match ampere rating of panelboard bus or equipment line terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wires and Cables:
   1. Conductor Installation:
      a. Install conductors in raceways having adequate, code size cross-sectional area for wires indicated.
      b. Install conductors with care to avoid damage to insulation.
      c. Do not apply greater tension on conductors than recommended by manufacturer during installation.
      d. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFCI circuit breakers or GFCI receptacles.
   2. Conductor Size and Quantity:
      a. Install no conductors smaller than 12AWG unless otherwise shown.
      b. Provide required conductors for a fully operable system.
   3. Conductors in Cabinets:
      a. Cable and branch wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
      b. Tie and bundle feeder conductors in wireways of panelboards.
      c. Hold conductors away from sharp metal edges.
   4. Exposed cable is not allowed.

END OF SECTION 260519
SECTION 260533 – RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Raceways.
   2. Conduit fittings.

1.2 SYSTEM DESCRIPTION

A. Provide raceways, wires, cables, connector, boxes, devices, finish plates and the like for a complete and operational electrical system.

B. Electrical Connections: Connect equipment, electrically complete.

C. Supporting Devices: Safety factor of 4 required for every fastening device or support for electrical equipment installed. Support to withstand four times weight of equipment it supports. Provide seismic bracing per CBC requirements for this building location.

1.3 SUBMITTALS

A. Submit For:
   1. Raceways.
   2. Conduit fittings.
   3. Surface metal raceways.

1.4 REFERENCED STANDARDS

A. General:
   1. The following documents form part of the Specifications to the extent stated. Bring conflicts between Specifications, Drawings, and the referenced standards to the attention of the Project Manager, in writing, for resolution before taking any related action.
   2. The editions (date) for the of the referenced standards shall be as follows:
      a. Standards referenced in the CBC: The edition shall be that required by the CBC adopted by SLAC on the date the Notice to Proceed with the Work is given.
      b. Other Standards: The edition shall be that in effect the date the Notice to Proceed with the Work is given.

B. Conform to the latest adopted version of the National Electrical Code (NEC).

C. Furnish products listed by UL or other testing firm acceptable to AHJ.
1.5 SEQUENCING AND SCHEDULING

A. Raceway System is Defined as Consisting of: Conduit, tubing or duct and fittings including but not limited to connectors, couplings, offsets, elbows, bushings, expansion and deflection fittings and other components and accessories. Complete electrical raceway installation before starting the installation of conductors and cables.

B. Finished Surfaces: Prevent cutting in connection with finished work. Make repairs in a manner approved by Project Manager.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Raceways: Allied Steel, Certainteed, Jones & Laughlin, Carlon, Kraloy, or approved.

B. Conduit Fittings: O-Z Gedney, Thomas & Betts, Crouse & Hinds, or approved.

2.2 CONDUITS

A. Galvanized Rigid Steel Conduit (RMC):
   1. Hot-dip galvanized after thread cutting.
   2. Manufacture in conformance with UL 514 and ANSI C80.1.
   3. Uniform finish coat with chromate for added protection.

B. Rigid Aluminum Conduit: Alloy 6063, threaded at each connection.

C. Electrical Metallic Tubing (EMT):
   1. Hot-dip galvanized and chromate coated.
   2. Manufacture in conformance with UL 797 and ANSI C80.3.

D. Flexible Conduit (FMC):
   1. Reduced wall flexible steel conduit.
   2. Hot-dip galvanized steel strip prior to forming and joining.
   4. Up to 1 inch trade size to be used on lighting and motors only.

2.3 CONDUIT FITTINGS

A. Bushings:
   1. Insulated Type for Threaded Rigid, IMC Conduit or Raceway Connectors without Factory Installed Plastic Throat Conductor Protection: Thomas & Betts 1222 Series or O-Z Gedney B Series.
   2. Insulated Grounding Type for Threaded Rigid, IMC Conduit and Conduit Connectors: O-Z Gedney BLG Series.

B. Raceway Connectors and EMT Couplings:
1. Steel conductor and coupling bodies, with zinc electroplate or hot-dip galvanizing.
2. Connector locknuts are steel, with threading meeting ASTM tolerances. Locknuts are zinc electroplated or hot-dip galvanized.
3. Connector throats (EMT, flexible conduit, metal clad cable and cordset connectors) have factory installed plastic inserts permanently installed. For normal cable or conductor exiting angles from the raceway (NEC bending radius), the cable jacket or conductor insulation bears only on the plastic throat insert.
4. Steel gland, Tomic or Breagle connectors and couplings are recognized for this Contract as having acceptable raceway to fitting electrical conductance.

C. Expansion/Deflection Fittings:
1. EMT, O-Z Gedney Type TX.
2. RMC, O-Z Gedney Type AX, DX and AXDX, Crouse & Hinds XD.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inserts, Anchors and Sleeves:
1. Coordinate location of inserts and anchor bolts for electrical systems prior to pouring concrete.
2. Coordinate location of sleeves for electrical systems prior to pouring concrete, with consideration for other building systems.

3.2 INSTALLATION

A. Conduit:
1. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal PVC conduit joints with solvent cement and metal conduit with metal thread primer. Rigid conduit connections to be threaded, clean and tight (metal to metal). Threadless connections are not permitted for RMC.

2. Conduit Placement:
   a. Install continuous conduit and raceways for electrical power wiring.
   b. Conceal conduits. Exposed conduits are permitted only in the following areas:
      1) Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished materials.
      2) Existing walls that are concrete or block construction.
   c. Where exposed conduits are permitted install parallel or at right angles to building lines, tight to finished surfaces and neatly offset into boxes.
   d. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block the area passage's intended usage.
   e. Do not install conduits on surface of building exterior, across roof, on top of parapet walls, or across floors.
   f. Route raceway at least 6 inches from hot surfaces above 120F, including noninsulated steam lines, heat ducts, and the like.

3. Below Grade Conduit and Cables:
a. Place a minimum 3 inch cover of sand or clean earth fill around the cable or
cable on a leveled trench bottom. Lay conduit on a smooth level trench bottom,
so that contact is made for its entire length.
b. Remove water from trench before electrical conduit is installed.
c. When three or more conduits are in a single trench, use conduit spacers that will
maintain 3 inch spacing between the conduits. Provide spacers on 5 foot centers.
4. Maximum Bends: Install code sized pull boxes to restrict maximum bends in a run of
conduit to 270 degrees.
5. Conduit Terminations: Provide conduits shown on Drawings which terminate without
box, panel, cabinet or conduit fitting with not less than five full threads. Bushings
and metal washer type sealer between bushing and conduit end.
6. Flexible Conduit: Install 12 inch minimum slack loop on flexible metallic conduit and PVC
coated flexible metallic conduit.
7. Conduit Size: Provide conduit in minimum code permitted size for THW conductors of
quantity shown. Minimum trade size 3/4 inch.
8. Conduit Use Locations:
a. Underground: PVC.
b. Exterior locations and Wet Locations, Classified Locations, Other and Subject to
Mechanical Damage: RMC.
c. Damp Locations: RMC and EMT up to 2 inches in diameter.
d. Cast-In-Place Concrete and Masonry: RMC and PVC.
e. Dry, Protected: RMC, EMT.
f. Sharp Bends and Elbows: RMC, EMT use factory elbows.
g. Install pull wire or nylon cord in empty raceways provided for other systems.
Secure wire or cord at each end.
h. Elbow for Low Energy Signal Systems: Use long radius factory ells where linking
sections of raceway for installation of signal cable.
i. Motors, recessed luminaires and equipment connections subject to movement or
vibration, use flexible metallic conduit.
j. Motors and equipment connections subject to movement or vibration and subjected
to any of the following conditions; exterior location, moist or humid atmosphere,
water spray, oil or grease use PVC coated liquid tight flexible metallic conduit.
9. Branch Circuits: Homers for 20 amp branch circuits may be combined to a maximum
of six conductors in a homerun. Apply derating factors. Increase conductor size
as needed.
10. Feeders: Do not combine feeder runs.
11. Unless otherwise indicated, provide raceway systems for conductors.

B. Conduit Fittings:
1. Set screw type fittings are not allowed.
2. Use compression fittings in dry locations, damp and rain-exposed locations. Maximum
size permitted in damp locations and locations exposed to rain is 2 inches in
diameter.
3. Use threaded type fittings in wet locations, hazardous locations, and damp or rain-
exposed locations where conduit size is greater than 2 inches.
4. Use PVC coated rigid steel conduit ells for underground power and telephone service
entrance conduits. Use 36-inch radius ells for power service conduits and 48-
inches radius ells for telephone service conduits.
5. Use insulated type bushings with ground provision at switchboards, panelboards, safety
disconnect switches, junction boxes and the like that have feeders 60 amperes
and greater.
6. Provide bushing or EMT connector for conduits that do not terminate in box, enclosure, or
7. Provide conduit expansion fittings at building expansion joints and at locations where conduit is exposed to thermal expansion and contraction.
8. Condulets and Conduit Bodies: Do not use condulets and conduit bodies in conduits for signal wiring, in feeders 100 amp and larger.

C. Sleeves and Chases - Floor, Ceiling and Wall Penetrations: Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceiling or walls.

D. Building Seismic Joints: Conduit crossing building seismic joints: provide box on either side of joint and flexible conduit between the box. Provide for a minimum of 12 inches of movement at the seismic joint. Rigid conduit crossings at seismic joints are not acceptable.

END OF SECTION 260533
SECTION 260534 – BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Outlet boxes.
   2. Weatherproof outlet boxes.

1.2 SYSTEM DESCRIPTION

A. Outlet System: Provide electrical boxes and fittings for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts, and other necessary components.

B. Flush Outlets in Insulated Spaces: Maintain integrity of insulation and vapor barrier.

1.3 SUBMITTALS

A. Provide shop drawings and product data for the following equipment:
   1. Outlet boxes.
   2. Weatherproof outlet boxes.

1.4 REFERENCED STANDARDS

A. General:
   1. The following documents form part of the Specifications to the extent stated. Bring conflicts between Specifications, Drawings, and the referenced standards to the attention of the Project Manager, in writing, for resolution before taking any related action.
   2. The editions (date) for the of the referenced standards shall be as follows:
      a. Standards referenced in the CBC: The edition shall be that required by the CBC adopted by SLAC on the date the Notice to Proceed with the Work is given.
      b. Other Standards: The edition shall be that in effect the date the Notice to Proceed with the Work is given.

B. Conform to the latest adopted version of the National Electrical Code (NEC).

C. Furnish products listed by UL or other testing firm acceptable to AHJ.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Outlet Boxes: Bowers, Hubbell, or approved.
B. Weatherproof Outlet Boxes: Pass and Seymour, Bell, Red Dot, Carlon, or approved.
C. Junction and Pull Boxes: B-Line, Hoffman, or approved.
D. Box Extension Adapter: Pass and Seymour, Bell, Red Dot, Carlon, or approved.
E. Conduit Fittings: O-Z Gedney, Thomas & Betts, or approved.
F. Outlet Box Backing Pad: Lowry Outlet Box Pad or approved.

2.2 OUTLET BOXES

A. Luminaire Outlet: 4-inch octagonal box, 1-1/2 inches deep with 3/8-inch luminaire stud if required. Provide raised covers on bracket outlets and on ceiling outlets.
B. Device Outlet: Installation of one or two devices at common location, minimum 4 inches square, minimum 1-1/2 inches deep. Single- or two-gang flush device raised covers. Hubbell.
C. Multiple Devices: Three or more devices at common location. Install one-piece gang boxes with one-piece device cover. Install one device per gang.
D. Masonry Boxes: Outlets in concrete, Hubbell.
E. Construction: Provide galvanized steel interior outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
F. Accessories: Provide outlet box accessories for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

2.3 JUNCTION AND PULL BOXES

A. Construction: Provide ANSI 49 gray enamel painted sheet steel junction and pull boxes, with screw-on covers; of the type shape and size, to suit each respective location and installation; with welded seams and equipped with steel nuts, bolts, screws and washers.
B. Location:
   1. Install junction boxes above accessible ceilings for drops into walls for receptacle outlets from overhead.
2. Install junction boxes and pull boxes to facilitate the installation of conductors and limiting the accumulated angular sum of bends between boxes, cabinets and appliances to 270 degrees.

2.4 CONDUIT FITTINGS

A. Requirements: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

B. Round Boxes: Avoid using round boxes where conduit must enter through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.

C. Anchoring: Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

D. Special Application: Provide weatherproof outlets for locations exposed to weather or moisture.

E. Knockout Closures: Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Mount center of outlet boxes, unless otherwise required by ADA, or noted on drawings, the following distances above the floor:
   1. Control Switches: 46 inches.
   2. Receptacles: 18 inches.
   3. Other Outlets: As indicated in other sections of specifications or as detailed on drawings.

G. Coordinate electrical device locations (switches, receptacles, and the like) to prevent mounting devices in mirrors, back splashes, behind cabinets, and the like.

H. Seal the back of boxes in acoustically rated assemblies with an outlet box backing pad and caulk gap between box and wall with non-hardening acoustical caulk.

END OF SECTION 260534
SECTION 260553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment identification labels.
   2. Conductor identification numbers.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Coordinate names, abbreviations and other designations with equipment specified in this
      or other Divisions of the Specification or identified on Drawings.
   2. Fasten labels to equipment in a secure and permanent manner.
   3. Mark underground utilities in conformance with APWA.

1.3 REFERENCED STANDARDS

A. General:
   1. The following documents form part of the Specifications to the extent stated. Bring
      conflicts between Specifications, Drawings, and the referenced standards to the attention
      of the Project Manager, in writing, for resolution before taking any related action.
   2. The editions (date) for the of the referenced standards shall be as follows:
      a. Standards referenced in the CBC. The edition shall be that required by the CBC
         adopted by SLAC on the date the Notice to Proceed with the Work is given.
      b. Other Standards. The edition shall be that in effect the date the Notice to Proceed
         with the Work is given.

B. Conform to the latest adopted version of the National Electrical Code (NEC).

C. Furnish products listed by UL or other testing firm acceptable to AHJ.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Engraved Labels: Lamicoid, or approved.

B. Conductor Numbers: Brady, or approved.

2.2 ENGRAVED LABELS
A. Melamine plastic laminate, white with black core, 1/16-inch thick.

B. Engravers standard letter style, minimum 3/16-inch high capital letters.

C. Drill or punch labels for mechanical fastening except where adhesive mounting is necessary because of substrate. Use self tapping stainless steel screws.

D. Dymo tape labels are not acceptable.

2.3 CONDUCTOR NUMBERS

A. Manufacturers standard vinyl-cloth self-adhesive cable and conductor markers of the wraparound type. Preprinted black numbers on yellow field.

2.4 BRANCH CIRCUIT SCHEDULES

A. Provide branch circuit identification schedules, typewritten, clearly filled out, to identify load connected to each circuit and location of load. Numbers to correspond to numbers assigned to each circuit breaker pole position.

B. Provide two columns, odd numbers in left column, even numbers in right column, with 3-inch-wide line for typing connected load information.

2.5 CIRCUIT BREAKER IDENTIFICATION

A. Provide permanent identification number in or on panelboard dead-front adjacent to each circuit breaker pole position. Square D adhesive is approved, other adhesives by specific prior approval only.

B. Horizontal centerline of engraved numbers to correspond with centerline of circuit breaker pole position.

PART 3 - EXECUTION

3.1 GRAPHICS

A. Coordinate names, abbreviations and designations used on Drawings with equipment labels.

3.2 CONDUCTOR IDENTIFICATION

A. Apply markers on each conductor for power, control, signaling and communications circuits where wires of more than one circuit are present. Provision for identifying wires within a control system, e.g. wire ID between a relay contact and a permissive, panel light, etc.

B. Match conductor identification used in panelboards for Division 26 work.
3.3 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install an engraved label on each major unit of electrical equipment indicating both equipment name and circuit serving equipment (e.g. "EF-1, CKT. 2P1-1,3,5"), including but not limited to the following items:
1. Disconnect switches, identify item of equipment controlled.
2. Time switches.
3. Override switches.

3.4 APPLICATION

A. Install engraved on the inside of flush panels, visible when door is opened. Install label on outside of surface panel.

B. Install signs at locations detailed or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment.

C. Where signs are to be applied to surfaces which require finish, install identification after completion of painting.

D. On the front of receptacle and switch finish plates provide label with the circuit that each device is connected to. Label is self-adhesive type with black letters and clear background, 18 point lettering size.

E. On the back of receptacle and switch finish plates, legibly write with indelible ink pen the circuit that each device is connected to.

END OF SECTION 260553
SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall switches.
   2. Receptacles.
   3. Device plates.
   4. Surface covers.

1.2 SYSTEM DESCRIPTION

A. Provide devices and finish plates for a complete and operational electrical system.

1.3 SUBMITTALS

A. Provide product data for the following equipment:
   1. Wall switches.
   2. Receptacles.
   3. Finish plates.

B. Provide product data for project closeout for the following equipment, see Project Close-Out Requirements in Division 01:
   1. Wall switches
   2. Receptacles.
   3. Finish plates.

1.4 REFERENCED STANDARDS

A. General:
   1. The following documents form part of the Specifications to the extent stated. Bring conflicts between Specifications, Drawings, and the referenced standards to the attention of the Project Manager, in writing, for resolution before taking any related action.
   2. The editions (date) for the of the referenced standards shall be as follows:
      a. Standards referenced in the CBC: The edition shall be that required by the CBC adopted by SLAC on the date the Notice to Proceed with the Work is given.
      b. Other Standards: The edition shall be that in effect the date the Notice to Proceed with the Work is given.

B. Conform to the latest adopted version of the National Electric Code (NEC).

C. Furnish products listed by UL or other testing firm acceptable to AHJ.

switches and receptacles respectively.

E. NEMA Configuration: Comply with NEMA configurations and standards for general and special purpose wiring devices.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Characteristics: Toggle type, quiet acting, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage, extra heavy duty. Leviton 1221, Pass & Seymour PS20AC1, Hubbell HBL1221.

B. Finish: Ivory finish unless selected otherwise by Project Manager. Provide Project Manager with optional colors for selection prior to ordering.

C. Appearance: Provide lighting switches and receptacles of common manufacturer and appearance.

2.2 RECEPTACLES

A. Finish: Same exposed finish as switches. Receptacles connected to emergency circuits, red finish.


C. Ground Fault Circuit Interrupter (GFCI) Receptacle: Meets or exceeds UL943 (Class A GFCI), UL498. Feed through type, back-and-side wired, tamper-resistant, weather resistant self-testing, 20 amp, 125VAC. Hubbell GFR5362SB, Cooper WRVGF20, Pass & Seymour 2095TRWR.

D. UL Wet-Listed Covers While-In-Use: NEMA 3R when closed over energized plug. Vertical mount for duplex receptacle. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit. Die cast aluminum cover with closed cell neoprene foam gasket. Intermatic WP1010MC.

E. Special Purpose Receptacles: Refer to Drawings for NEMA Standard Specification.

2.3 FINISH PLATES

A. Finish Plates: Commercial grade thermoplastic, finish to match device finish.

2.4 SURFACE COVERS
SLAC-I-383-100-03-R000

A. Material: Galvanized or cadmium plated steel, 1/2-inch raised industrial type with openings appropriate for devices installed on surface outlets.

B. Cast Box and Extension Adaptors: Aluminum, with gasket, blank. Single gang, Bell 240-ALF, Carlon, 2 gang. Bell 236-ALF, Carlon, or approved.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection:
   1. Devices: Upon installation of wall plates and receptacles, advise Subcontractor regarding proper and cautious use of convenience outlets. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty receptacles or cord caps.
   2. Finish Plates and Devices: Do not install items until finish painting is complete. Scratched or splattered finish plates and devices not acceptable.

3.2 INSTALLATION

A. Plumb: Install devices and finish plates plumb with building lines and equipment cabinets.

B. Orientation:
   1. Wall-Mounted Receptacles: Install with long dimension oriented vertically at centerline height shown on Drawings or specified herein.
   2. Vertical Alignment: When more than one outlet is shown on Drawings in close proximity to each other, but at different elevations, align the outlets on a common vertical center line for best appearance. Verify with Project Manager.

3.3 FIELD QUALITY CONTROL

A. Wiring Device Tests: Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

END OF SECTION 262726